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DRY BATTERIES.

In another column we print an instructive article from the pen of Dr. Böhm on dry batteries, which adds considerable information to a subject that thus far has been rather meagrely treated. It will be seen that the term "dry battery" is a misnomer, as the action of such cells is absolutely dependent upon the presence of moisture. In one of the first commercial forms of dry battery this moisture was supplied when the cell was set up for use by introducing water through an orifice provided for the purpose, but in the later types the excitant is placed in the cell in a moist state. As remarked by Dr. Böhm, the action of a dry cell does not differ from that of an ordinary voltaic cell, which explains the necessity for moisture to act as the electrolyte. The amount of moisture necessary is only so much as to supply a continuous electrolytic medium between the elements; how attenuated this medium may be is shown in the old forms of laboratory dry cells, one of which is in existence that has been continuously in operation for over two-score years, supplying continuously during that time a static charge to pith balls on an oscillating arm, the necessary moisture being derived from the air.

CRUDE PETROLEUM AS A FUEL.

The abstract we print elsewhere of a paper by Mr. A. M. Hunt gives some definite practical figures as to the value of crude petroleum as fuel compared with coal, which differ somewhat from corresponding data often printed. The tests from which the present data were obtained were made under practical conditions during the Midwinter Fair at San Francisco last year, and take into consideration several factors usually neglected. It is shown that the usual claim of great superiority of oil over coal is based upon an evaporative efficiency of a boiler unattainable in practice. The results reached in the Midwinter Fair tests show an evaporation of 14.2 pounds of water per pound of oil which, assuming the theoretical evaporation to be 20.7 pounds, gives a boiler efficiency of about 70 per cent. which is about what is commonly attained in ordinary practice. The table given is interesting as contrasting the efficiency of oil as often given with its actual efficiency, taking into consideration the economies resulting from there being no coal and ashes to handle, etc. The difference is not as great as might have been expected; with oil, for instance, at $1.50 per barrel the comparative cost of coal per ton is reduced from $5.51 to $4.94. This scarcely bears out the great claims sometimes made for savings due to these factors. From the figures given it will be seen that oil may be an economical substitute for coal where the price of the latter is high and where oil can be delivered at a reasonable cost for freight, and it is probable that these conditions apply in many cities west of the Mississippi and in parts of the South. The subject is one well worth looking up by central and power station managers where coal is dear, and to these the information in the paper of Mr. Hunt can be recommended as practical and reliable.

ELECTRICAL CONSONANCE.

The article by Dr. Pupin, printed elsewhere, is another illustration of the value of analogies in investigating or explaining an intricate subject. The phenomena of sound are so much simpler to comprehend than the phenomena of alternating circuits containing capacity and inductance, and the analogy between the two may be made so convincing, that it is surprising that more use has not been made of this method. In the present instance Dr. Pupin complements his notable investigations in resonance by one along similar lines into what, from analogy, is called electrical consonance. In the former case it was shown how by a suitable adjustment of capacity and inductance a circuit may be turned into synchronism with electromagnetic waves of a certain periodicity,

while in the case under consideration an effect somewhat similar with respect to increase of current is produced by the action of one circuit electromagnetically connected with another, though the natural period of the latter is not the same as that of the impressed E. M. F. acting. Unlike the former case also, the current may be a maximum for two values, as the primary apparent self-inductance may be neutralized at either of two values for a given frequency, primary self-inductance or secondary resistance. While the present contribution of Dr. Pupin is one of much theoretical interest its practical significance is less than that of his former researches into resonance on account of the difficulty of producing the necessary adjustments. The author, while admitting this, remarks, however, that as a phase-changing device the method may be of service in the future, particularly in connection with a high tension primary circuit where a condenser could not well be directly introduced into the circuit.

THE MONOCYCLIC ALTERNATING SYSTEM.

Elsewhere we print an account of the monocyclic system of Mr. Charles Proteus Steinmetz, compiled from eight patents recently granted to the inventor. The main features of the system are the addition of a supplementary coil to the usual type of alternator generating simple alternating currents, and the employment of induction motors having primary windings similar to the armature windings of the generator. The main winding of the alternator generates simple alternating currents which supply incandescent lamps in the usual manner and furnish the working current of motors, the starting torque of the latter being obtained through the current supplied by the line connecting with the supplementary coils of the generator and motor respectively. It is shown that when the motors connected are in operation, little or no current is supplied by the supplementary wire; that under-loaded motors will supply current to this line and over-loaded motors will absorb current from it. If a number of monocyclic motors are installed it may not be necessary to have other than a simple alternator, as the supplementary current for starting a motor may, if other motors are in operation, be derived solely from the line connecting the supplementary coils of the various motors. Another method described which also allows the use of a simple alternator, consists in the employment of a motor generator, which is supplied with current from the simple alternating mains and generates an E. M. F. of displaced phase for the supplementary line, thus obviating running the latter line from, perhaps, a distant station. In addition to motor-generators for transforming phases—called phase converters—static phase transformers are also described, which seem to be identical in principle with those that formed the subject of Mr. C. F. Scott's notable paper read at the Convention of the National Electric Light Association last year. The reader will find many other interesting details in the article referred to, which strikingly illustrates the beautiful flexibility of the alternating current, while the patents furnish in themselves, it may be added, the best practical treatise on the alternating current, within the limits which the subject impose, that has yet appeared in print.

THE "DEADLY TROLLEY" IN CHICAGO.

One would scarcely think that at this day Chicago—bustling, hustling Chicago of all cities—would take up the absurd cry of the "deadly trolley," yet such seems to be the case. Recently the City Councils granted important franchises for trolley roads in streets located in the central part of the city, and immediately both editor and cartoonist sounded the alarum and called upon the public to take measures to avert a threatened calamity. In a city where, it is reported, the steam cars daily claim a victim, it is rather incongruous to raise such an outcry, particularly as experience with the steam roads should have rendered the citizens so proficient in dodging, that the trolley car, even if it possessed the dangerous character ascribed, would seem, after all, to give little occasion for alarm. In the present case, however, we are inclined to believe that the opposition to granting the franchise springs from a dislike for the unpopular personage who is to be the recipient of the favor of the Councils, which is another instance of the manner in which electric traction has to bear the burden of other evils. The most striking example of this unjust spirit is in ascribing the accidents due to the faster speed of electric cars to the motive power. If trolley cars were run at the same speed as the horse cars they have displaced, there would be little or no occasion for the cry of the "deadly trolley," for the accidents due to the electrical current employed are now so rare on account of more careful construction of lines, as to present no greater element of danger than did the horse traction system displaced. If the true cause of accidents—high speed—were not obscured by the senseless fulminations against the "deadly trolley," the public would be much the gainer, as attention would then be directed to the question of speed, which is the real matter to be considered in relation to the subject of accidents. We presume that the franchises referred to were sought because the public needs better facilities for travel in the territory covered, and if high speeds, involving danger to life, are contemplated, the remedy does not lie in refusing to grant the public any facilities whatever, but in regulating the speed. Were the question regarded from this point of view it would result in placing the responsibility where it belongs—with the public that demands rapid transit, and which now places on electric traction as a system the burden of any evil that ensues.

The National Electric Light Association.

Arrangements have been completed by the secretary of the National Electric Light Association with the New York Central and Hudson River Railroad Company for a special train to Cleveland of Wagner vestibule, parlor, dining room and buffet cars, leaving Grand Central Depot, 42d street, New York, at 9:30 a. m. Monday, February 18, running as second section of the fast mail on the following schedule: Leaving New York at 9:30 a. m.; Albany, 1 p. m.; Utica, 3:17 p. m.; Syracuse, 4:40 p. m.; Rochester, 6:30 p. m.; Buffalo, 7:25 p. m. (central time); Erie, 9:33 p. m. (central time); arriving at Cleveland, 11:55 p. m. (central time). Seats can now be secured on this train by applying in person or by letter to the office of the National Electric Light Association.

A special rate has been granted (on certificate plan) of a fare and one-third from all points in the United States east of the Mississippi River, Peoria and Chicago, Ill., to Cleveland. To obtain this rate it is necessary in purchasing a going ticket to ask the agent for a certificate, which, when properly endorsed at Cleveland, will entitle the purchaser to a one-third fare returning. That the best results may be obtained it is very desirable that delegates should make their application for space on the New York special at the earliest possible moment.

The following gentlemen have charge of transportation in their respective districts, to whom application can be made for all information: A. C. Shaw, 620 Atlantic avenue, Boston, Mass.; H. A. Cleverly, 1,018 Chestnut street, Philadelphia, Pa.; E. H. Heinrichs, Westinghouse Electric Company, Pittsburgh, Pa.; E. L. Powers, Monadnock Building, Chicago, Ill.

In addition to the papers and topics heretofore announced for the Cleveland programme, there will be a paper entitled "A New Method of Measuring Illumination," by Messrs. E. J. Houston and A. E. Kennelly. Among the topics for discussion are "Underwriters' Rules vs. National Electric Light Association Rules," and "Practical Demonstration of Protecting Lines from Lightning," in which Mr. A. J. Wurtz will take part.

Combination Alternating and Direct Current Generators.

Expert W. S. Rugg, of the Westinghouse Company, successfully tried the experiment at Rochester last week of working three combination alternating and direct current generators in multiple arc as to both sides of the machines.

These generators furnish a two-phase, alternating current of 385 volts electromotive force from one set of brushes, which current is "stepped-up" to 2,000 volts line potential; the other set of brushes furnishes direct current at 500 volts. In the experiment all the alternating current windings were put in multiple arc on one set of bus bars, and all the direct current windings were connected in multiple on another set of bars. The result is reported as having been entirely satisfactory.

Electrical Difference of Potential.

BY WM. A. ANTHONY.

In a recent issue of THE ELECTRICAL WORLD I notice that a correspondent called in question the statement that maintaining a potential difference consumes no energy and claims that if energy is required to establish potential difference it must be required to maintain it. I do not see that this follows, for the energy required to establish potential difference is that represented by the transfer of the quantity of electricity required to charge the dynamo conductor and terminals—equal to EQ, where E is the potential difference, and Q the quantity required to charge the conductor and terminals to the potential difference E.

Suppose the E. M. F. of the machine to be one volt, and the capacity of the terminals one farad, then one coulomb must be transferred to create a potential difference of one volt. When this is done the potential difference exactly balances the E. M. F., the flow of electricity ceases and with it the consumption of energy. We may suppose the resistance, or self-induction, or both, to be such that any given time may be required to effect this transfer. If the transfer is effective in one-tenth second the average current is ten amperes, and the average rate of working ten watts; if it is effected in one second the average current is one ampere, and the average rate of working one watt. If it is effected in one minute the average current is $\frac{1}{60}$ ampere and the average rate of working $\frac{1}{60}$ watt. But in each case the total work done is 10^7 ergs. This work is done partly in heating the conductor—the armature winding—and partly against the rising potential difference. In any practical case the capacity is, of course, extremely small; the quantity of electricity transferred and the time and energy involved in the transfer are, therefore, extremely small.

But while it is true that no energy is required to maintain a potential difference once established it is not true that energy is not consumed in connection with the maintenance of the potential difference in machines of the ordinary types when running an open circuit. In a Gramme or Siemens armature the coil that connects directly to the positive brush at a high potential and the one connected to the negative brush is at a low potential. As the armature revolves the potential of a given coil will gradually change through a range equal to the E. M. F. of the machine, and as it changes a quantity of electricity must flow out of it or into it sufficient to change it to the potential due to that E. M. F. As an example, suppose a two-pole Gramme-ring machine running an open circuit at a potential difference of 100 volts. A coil at the positive brush is charged to a potential of 100 volts. It gradually loses its charge as it is carried toward the negative brush and at the end of half a revolution has entirely lost it. At the same time the opposite coil in moving from the negative to the positive brush gains an equal charge. It is exactly as though the quantity of electricity required to charge one armature coil to a potential of 100 volts flowed through the entire armature winding during each half revolution. If q = the quantity required to charge one coil and n the number of revolutions per minute, $\frac{60}{2n}$ is the time of a half revolution and $\frac{q}{\frac{60}{2n}} = \frac{qn}{30}$ is the current flowing through the armature wires. If r = the resistance of the armature winding considered as one continuous wire, then $\left(\frac{qn}{30}\right)^2 r$ is the power continually consumed.

In an alternating current machine on open circuit electricity is being constantly transferred back and forth from one terminal to the other, and if the machine is connected to line, the circuit still open, the electricity required to charge the line is alternately transferred through the machines from one side to the other. Suppose the line to have a capacity of one microfarad—not an excessive capacity for long distance transmission, especially for concentric conductors—and the potential to be 10,000 volts, $\frac{1}{100}$ of a coulomb is required to charge the line to this potential, and this amount must flow through the machine during every half period. If there are 250 half pounds per second there is an average current of 2.5 amperes. In other words, if the machine were connected to line through 5 incandescent lamps in parallel each requiring ½ ampere the lamps would be maintained at full incandescence.

The point I wish to make is that the energy required to establish a potential difference is accounted for by the flow of the electricity necessary to charge the conductor and is computed exactly as in any other case of electric flow. When the potential difference is established and the flow ceases there is no longer anything to account for a consumption of energy, hence no energy is required to maintain the difference.

The Record of the Year 1894 In Great Britain.

(From Our Own Correspondent.)

The past year, although by no means one of great prosperity, has not, on the other hand, been so bad as many would like to make us believe. The total volume of business transacted has not, apparently, been unsatisfactory, although, owing to the number of firms engaged in the business, there has been the natural consequences: keen competition, keeping down prices, and each individual firm's share of the total work being diminutive. Judging by the returns of the various electricity supply companies for the year ending December 31, the progress of electric lighting in this country does not, as yet, show any sign of slackening, and although some contend that the growth of central station supply checks the demand for isolated plants, there have been, so far as one can tell, a large number of orders for big isolated plants for railway stations, goods yards, monster hotels, and country houses. Ship lighting. also, is ever with us in undiminished popularity. There are, at the present moment, nearly 1,600,000 8 cp lamps connected to the mains of electricity supply companies in the United Kingdom; the lamps being almost equally divided between alternating and continuous current systems. This figure is an increase of over 400 per cent. upon the total for 1893. It is curious to note that, notwithstanding the other that has been made about municipal electric lighting, it is, judging by its lamp connections, still insignificant, compared with the electric lighting undertaken by private capitalists. At the end of 1894, the lamps connected to the mains of statutory electricity supply companies amounted to 1,200,000 in round figures; the lamps connected to the mains of municipal concerns only aggregating 400,000. This state of things, however, is entirely due to London. Taking the provinces alone, there are 36,800 lights connected to municipal concerns, against 300,000 connected to the mains of companies. Our largest concern continues to be the Metropolitan Electric Supply Company, which supplies 206,000 8 cp lamps by means of transformers in consumers' houses. The next biggest company is the Westminster Electric Supply Corporation, which supplies 168,500 8 cp on the three-wire system. The third largest concern is the City of London Electric Lighting Company, the lamp connection of which at the end of the year was 136,000, supplied by transformers' sub-stations. The total lamp connection all over the metropolis, I may remark, is not far short of one million.

Electric traction on the other hand, still remains in a state of stagnation. There has not been a single new tramway or railway brought into operation during the past twelve months, and with the exception of the steel-tube underground electric railway which is to run from Waterloo station to the City, no work of first-class importance has been commenced, nor is there any in immediate prospect. Apart from climatic and social causes which militate largely against the success of tramways in this country, there can be no doubt that the continued existence of the municipal purchase clause in its present state must inevitably act as a deterrent, not merely to the promotion of new lines, but to the adoption of any improved system of traction. Either the municipalization of the tramways must be thoroughly carried out or a free hand must be given to private enterprise. The introduction of electricity in mines, like the adoption of electric traction, still hangs fire, and for reasons of much the same character. Mining is not a profitable businses just at present, and most of the men and many of the managers have naturally a rooted disinclination to give electro-mechanical devices fair play.

The advent of the incandescent gas burner has created something like a panic on the Continent, but has not made much stir with us; it being generally considered that it is not likely to replace the glow lamp anywhere where that lamp has already been installed, and that it need not be generally feared that it will induce people to retain gas, in place of going over to electricity. Although the tone of electric business men has been a subdued one, it is probable that more sound business has been done in 1894 than in any other year.

Consolation for Cranks.

Everyone wrestling with the forces of Nature is, in a sense, says the London *Engineer*, a perpetual motion man. We cannot think, it adds, that all this means so much waste of mental energy. No man trained to think will say that he knows what is and is not impossible in the future; at the best, he can but believe.

Direct-Connected Arc Lighting Station.

In THE ELECTRICAL WORLD of Dec. 29, appeared a brief announcement of the starting of the first direct connected arc lighting plant in the United States. We are able this week to give an illustration and fuller description of this interesting station.

The plant was installed and is operated by the Mutual Electric Light and Power Company, Chicago, the station of which is located at the intersection of Eighty-ninth and Loomis streets, about a mile from South Englewood station.

The building is 90 x 110 feet and of the best modern construction, with brick walls, terra cotta trimmings and iron roof. The dynamo room is about 40 x 100 feet and can accommodate a direct-connected plant of over 2,000 arc lamps capacity, of the type installed.

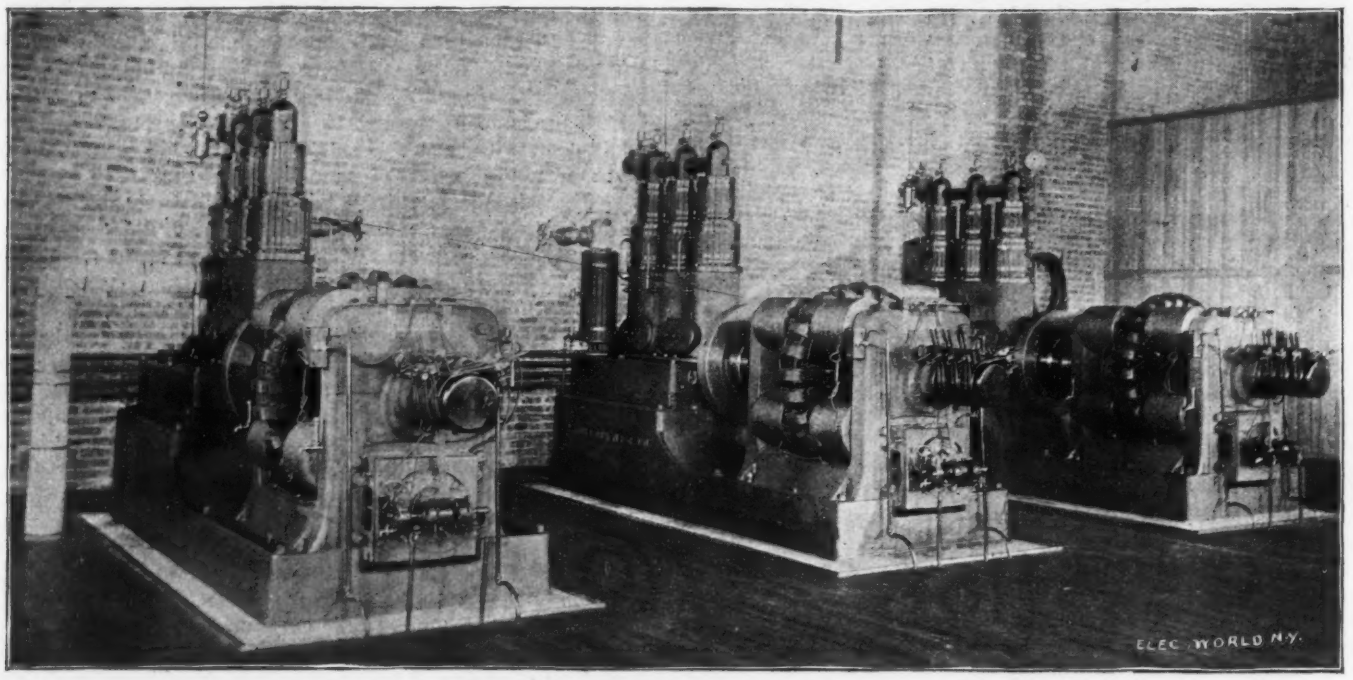
The plant at present includes three 125 arc Brush dynamos connected direct to three Willans high-speed engines as shown in the illustration; Brush-Adams 2,000-cp arc lamps, are used. Two 3,000 hp water tube boilers, built and installed by the Link Belt Manufacturing Company, of Chicago, constitute the boiler plant.

The shaft of the Willans engine is connected direct to the shaft of the dynamo by means of an insulated Brotherhood coupling, the engine and dynamo resting upon one bedplate 4 feet 6 inches x 10 feet 3 inches. The speed is 500 revolutions per minute. The manufacturers of the Willans engine guarantee as low as 21 pounds of water per horse power per hour, and expect to show even better results than this when the final tests are made.

The first dynamo started on the night of Dec. 17, 1894, and the last pair about the middle of January. The start was made without a hitch, and 15 minutes after the first revolution the entire load of 125 lamps was thrown on and continued to operate for the balance of the evening. The automatic regulator of the dynamo regulates so closely that any number of lights may be thrown on or off at will with impunity. The engine is very quick to govern, easily taking care of its end of the business, and thus the two work in perfect harmony and with economy, the amount of steam used being always approximately proportionate to the load carried by the engine.

This compact and efficient arc lighting plant is such an innovation in the matter of economy of floor space that its adoption in this instance will probably change the character of all future arc lighting stations, especially in cities where real estate is valuable. A space of four feet has been left between the floor of dynamo room and the ground which provides a convenient place for running wires from dynamos to switchboard and steam pipe from engine to heaters. This arrangement also provides a very easy method of installing additional pairs.

Taking into consideration this entire plant from beginning to end it embodies throughout the best machinery and best construction, and contains all the latest and best thought in the arc lighting industry.



DIRECT-CONNECTED ARC LIGHTING STATION. INTERIOR OF DYNAMO ROOM.

Maltha.

Considerable litigation is now pending relating to the use of maltha or insulating compounds and paints, and the following information in regard to this material may be of interest. "Maltha" was originally a Greek word applied to soft pitch and it is still used in connection with semi-fluid bitumen, which is found abundantly at the pitch or tar springs of California. By absorbing oxygen from the atmosphere the semi-fluid mass gradually hardens into asphaltum, and it is in this manner that the great pitch lakes of California have been formed as well as the extensive asphaltum deposits of Cuba and Trinidad. There is, however, one respect in which these otherwise similar substances differ, and that is in capacity for further oxidation, which is decidedly greater in the softer varieties. The hard asphaltums are more suitable for insulation purposes, and it is of these that the so-called insulating compounds and paints are made. The soft malthas forming the basis of these electrical insulators are concentrated by distilling off the oil, after which the residue is more or less clarified by settling.

From another source we obtain the information that while the derivation of the word "maltha" refers to soft pitch, there is no evidence whatever that the word was generally used in California to designate the material found in the pitch or tar springs of that State, previous to 10 years ago, when the word was first used there in connection with the residuum resulting from an application of processes at that time first applied. This residuum was described in the patents relating to it as being a "solid residuum of the distillation of heavy grades of petroleum," which we call "maltha," and the courts have taken the view that this word was merely a "fancy" name adopted by the owners of these patents at the beginning of operation, and in no way limited to the former definitions of the same word.

There is more than one way in which these residuums may be used in manufacture, as they can be applied both by reducing the residuum to a liquid by heat and also by putting it in the form of a liquid by the use of bisulphide of carbon or other solvents. It is claimed that a long series of experiments covering many years has shown the best solvent for this purpose is bisulphide of carbon, the use of which is patented. The action of this solvent is simply that of a vehicle which passes off rapidly after fulfilling its office, which is that of depositing on surfaces the residuum which has been found so excellent a preservative as well as acid and moisture resistant.

A decision of Judge Dallas of the Circuit Court of New Jersey holds as valid a patent for the coating of paper with a residuum of petroleum by means of the process just referred to.

The Niagara Power Transmission Plant.

BY FRANK C. PERKINS.

The Niagara Falls Power Company has applied to the city of Buffalo for a franchise to supply its citizens with electric current from the Niagara Falls plant. Thirteen deeds of right of way over property between Buffalo and Tonawanda in favor of the Cataract Construction Company were filed recently in the County Clerk's office. This gives the power company an almost complete line between the northerly city line of Buffalo and the southerly line of the village of Tonawanda; each of the deeds grants the use of a 30-foot strip west of and adjacent to the property of the N. Y. C. & H. R. R. In each deed it is specified that within two years the company will construct and operate power transmission lines for power, lighting and heating purposes, at its own cost and expense, either above or below the surface, the company agreeing to furnish power to each of the property owners on the most reasonable terms for which power is selling. Where or how the power line will go through the Tonawandas has not been settled, but that rights of way are being secured between Niagara Falls and Tonawanda is known to be a fact.

In Buffalo a resolution was defeated before the City Council proposing that the matter of dealing with the question of introducing current from Niagara into the city be taken from the street committee and placed with a special committee. Mr. George Zink proposed that a committee of three from the Board of Aldermen and three from the Board of Councilmen and the incoming Mayor make an effort to learn what the cost of power will be at the city line, and suggested that the city might distribute the power itself, taking care of all the poles, wires, etc. "All the factories along the canal could first be supplied, and a belt line formed around the city," said Mr. Zink. "Then as the demand increased, provision could be made for supplying the central portions of the city. The city could afford to be a loser for a year or two by giving a cheap rate. A cheap rate would boom the city. Why is the city going to allow a company to come in second hand and take care of the distributions? Why not let the city be the purchaser and the distributor? Mr. Zink continued, "For my part I had sooner see the city rather than any corporation handle and distribute this power." The Council adjourned without acting on the suggestion. The following resolution and others similar to it have been submitted by various associations in the city of Buffalo:

"Whereas, the Niagara Power Company and the Schoelkopf Canal Company are at present making application to the city for permission to use the public streets and roadways for the distribution of electric power;

"Resolved, That it is the opinion of this association that in view of the difficulties that present themselves in arranging satisfactory terms, it would be advisable that a committee be appointed to look into the subject of the city taking the power at the city limits and making the distribution within the city limits itself."

There is at the present time an animated discussion going on in the city of Buffalo on the actual cost of steam power, the method of distribution, and the maximum price to be charged for electric power. The Buffalo Electrical Society, the Merchants' Exchange, the Real Estate Exchange and other associations have been invited to appoint committees to act in an advisory capacity with the street committee, and it is expected that the conditions of the franchise and the granting of the same will be settled in a few days. The city officials are to visit the Niagara Falls power plant shortly to learn the exact condition of affairs at the present time.

The State of Affairs at the Power House.—Leaving the exciting scene of discussion in Buffalo, we will look over the power plant and view the preparations made to furnish the necessary current mentined by the company in the application for a franchise.

The first view the visitor has of the magnificent white stone power house impresses upon his mind the idea that the work is near completion and the vast storehouse of energy is soon to give forth the electric force which will operate mills and factories, propel street cars and railway trains, light the streets of the neighboring cities, and heat the stores and residences of their citizens. The illustration, Fig. 1, shows the completed power house at the right and the covered conductor bridge connecting it to the recently constructed transformer house at the left.

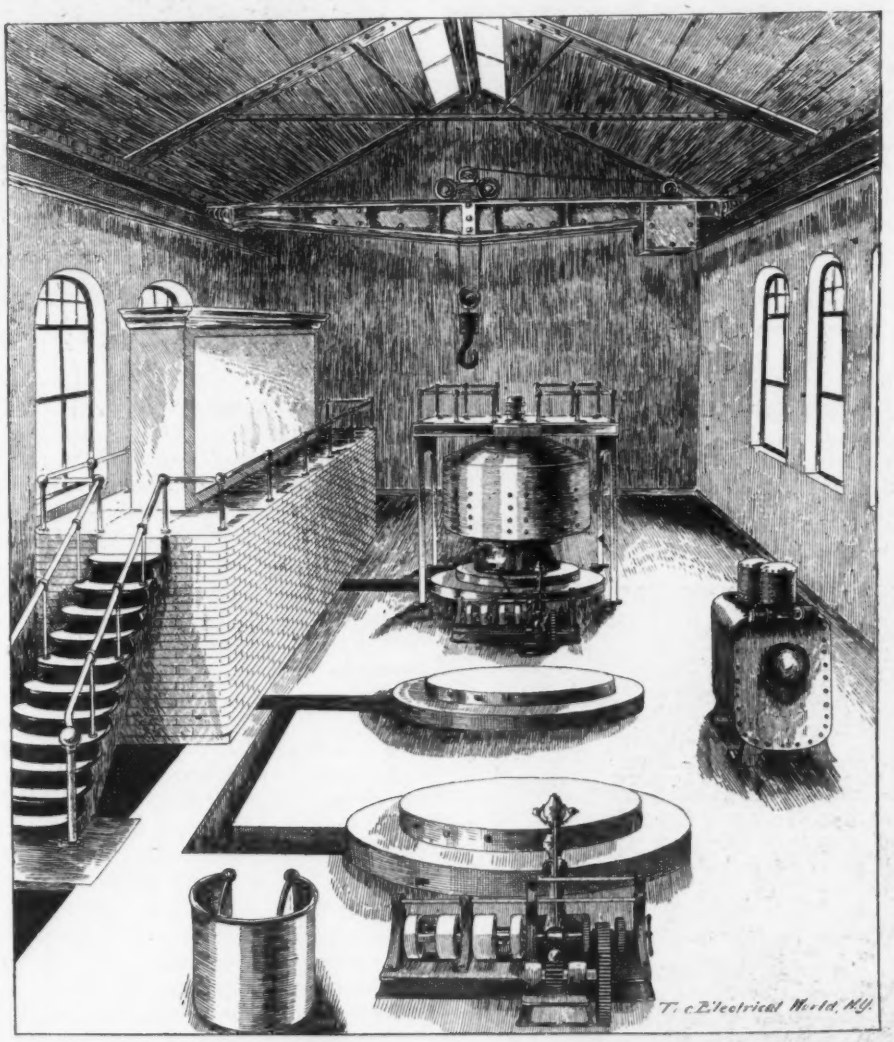


FIG. 1.—GOVERNOR, STAIRWAY AND VISITORS' GALLERY.

On entering the power house we find the electric crane in operation, assembling the heavy parts of the dynamos and other apparatus which are being placed in position. The electric crane was built by William Sellers & Co., of Philadelphia, and is operated by a Billberg electric motor at a potential of 220 volts. The electric elevator is being used continuously to carry workmen from the bottom of the wheel-pit to the various galleries where they are busy finishing and scraping the bearings of the vertical shafts. The elevator was designed and constructed by Otis Bros. & Co., and is operated by a 220 volt direct current motor. The switchboard for the elevator and lighting installation is constructed of marble, and is enclosed in a small room. The electric motor and hoisting apparatus is also temporarily enclosed in another small building in the power house to keep out the moisture arising from the wheel-pit below.

On going down the winding stairs through the circular opening, shown in the foreground of Fig. 1, the elevator landing is reached. On this landing one may see the perfectly balanced levers which are operated by the governors or regulators in opening or closing the gates of the turbines. The gearing may also be seen which connects the governors to the dynamo and to the turbine shaft.

One may also pass directly under the electric generators and see the various pipes which convey the lubricating oil and water to the bearings. One pipe conveys oil to the upper bearing of the dynamo, a second conveys oil to the lower bearing of the same machine, a third pipe allows water to pass to a cooling chamber of the

upper bearing, and a fourth pipe allows water to pass to a similar chamber in the lower bearing.

The Elevator and Wheel-Pit.—The elevator descends to the bottom of the wheel-pit, stopping at the various galleries and sub-galleries until the lowest landing above the turbines is reached. There are four galleries in the wheel-pit and three sub-galleries. Each gallery is now provided with four permanent incandescent lights, the conductors being run in iron pipes lined with insulating material. Each lamp is hermetically sealed in closed globe, and sockets, etc., are of rubber and carefully constructed to keep out moisture. The risers run from the bottom to the top of the wheel-pit in iron pipes, and iron junction boxes are provided on each gallery to supply the necessary lights. This construction work was done by the Western Electric Company, of Chicago, Ill. The current for supplying the electric elevator, electric crane and lighting is generated in a building near the river next to the city water works. The boiler is installed in the pumping station and furnishes steam to a Westinghouse Kodak plant. A 100 hp Westinghouse direct current generator of 220 volts is connected directly to a compound Westinghouse engine. The current is transmitted to the power house by an overhead pole line.

The view from the visitors' gallery shows the switchboard and foundation nearing completion, the subway running the length of the power house and under the switchboard, the conduits connecting the electric generator foundations with the switchboard, the governors being completed, the alternators being placed in position, and the oil-filtering cylinders, tank and pumps being made ready to lower into position on the deck at the bottom of the wheel-pit just above the turbines.

The opening of the gates which allow the water to pass from the canal to the turbines is to be accomplished by means of electric motors and suitable gearing, now being installed. The motors are Westinghouse 8-kw direct current motors of 220 volts potential and they are to be operated by the same current which is supplied for the electric elevator and electric crane. Two of these motors have already been installed, but are not coupled to the gearing or connected by electric conductors as yet.

The Regulating Apparatus.—The governor is seen in the foreground of Fig. 1, near the circular opening which leads to the

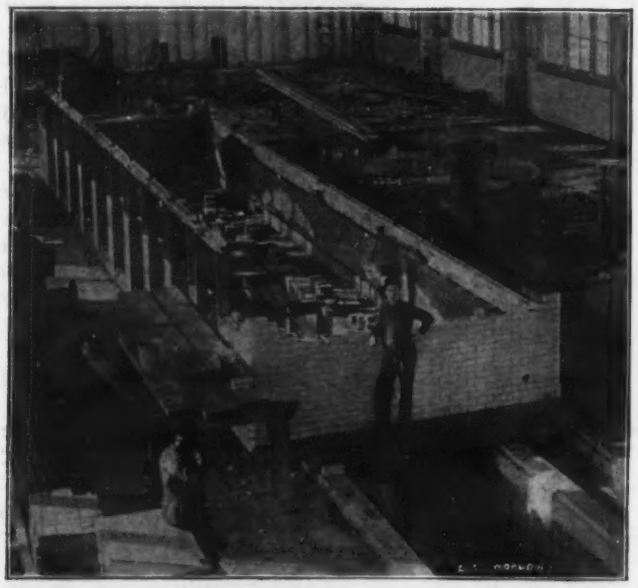


Fig. 2.—Interior of Power House.

elevator landing in the wheel-pit. There is a visitors' gallery, not shown in the illustrations. The levers connected to the governor are so delicately balanced that it only requires about four pounds to move the massive gates of any turbine. This may be done by hand or automatically operated by the governor. The governor is located beside the alternator and is coupled to it below the floor. It controls the speed of the generator by means of the levers above mentioned. This regulator is of a new type and is very sensitive to variation in speed, and in electrical installations is said to have done very good service. This regulator is calculated to control the speed at a normal rate of working within one-half of 1 per cent., and within about 3 per cent. if the load at the turbine is increased or diminished suddenly by one quarter load, or 1,250 hp. This is a remarkable result for any regulator in hydraulic work, and the working of this apparatus in practice with this great plant will be watched with interest. The designers of the turbines, Messrs. Faesch & Picard, of Geneva, Switzerland, are also the designers of this interesting regulating device. With a variation of from full load to no load, as in case of dead short circuit and the blowing of fuses or the circuit being opened by mistake, the engineers claim

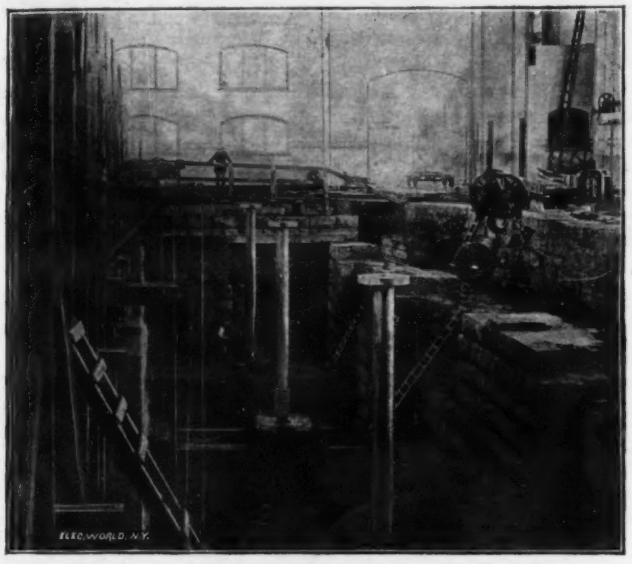


Fig. 3.—Vertical Shafts and Wheel-Pit.

the speed will not exceed 400 revolutions. The turbines and accompanying apparatus are designed to stand strains where the speed reaches 500 revolutions per minute, the normal speed being 250 revolutions per minute.

The Lubricating Apparatus.—The lubricating apparatus is especially interesting. The tank, cylinders and pumps are to be located at the bottom of the wheel-pit shown in Fig. 3; much attention has been given to these details. The main clean oil tank is constructed of steel and is located near the roof of the power house over the door. It will hold 200 cubic feet of oil; clean oil is to be placed in this tank, and conveyed by iron pipes to the bearings of the dynamo, and may also be allowed to pass through the various shaft bearings; the latter, however, having a separate and independent means of lubrication. After having accomplished its purpose in lubricating these bearings the oil is conducted into the filtering cylinders, and after the dirt has been extracted the clean oil passes into the tank below the cylinders. The pumps on the top of the tank then force the clean oil into the large tank near the roof of the power house. These pumps are operated by the waste water in the wheel-pit. The oil which comes from the bearings is first washed by passing it through water in the filtering cylinder and is then forced through felt in the upper part of the same cylinder. Only one filtering cylinder and pump are used at a time, the other being held in reserve to be used when one must be cleaned.

The main shaft bearings have an independent means of lubrication which is quite novel. A large cast iron cup is attached to the revolving shaft below the bearings; this cup is several feet in diameter and contains the lubricating oil; a pipe dips into the oil, and the centrifugal force carries the oil upward through the pipe to the top of the bearing and after thoroughly lubricating the bearing it finds its way back into the revolving cup. To supply the cup with fresh oil it is only necessary to open the valve and allow the dirty oil to pass to the filter below and the clean oil to fill the cup from the tank above.

Both the main shaft bearings and the dynamo bearings are also provided with chambers and pipes so connected that cold water may be allowed to pass from the city water mains through the bearings if it is found necessary to cool them.

The Switchboard and Foundation.—The switches are all to be mounted within the switchboard foundation and operated by compressed air by means of levers on the switchboard platform or gallery above. There will be mounted upon the switchboard the various indicators, ammeters, voltmeters and other measuring instruments which will require the attention of the engineers in

charge. It is understood that the main switches are to be operated by compressed air mechanism similar to the Westinghouse air-brake apparatus, the air compressor being operated by water power in the wheel-pit below. The openings in the switchboard foundation, in which are to be placed the plate glass doors leading to the cables and main switches, may be seen in Fig. 2. The switchboard is mounted on an iron and brickwork foundation, and is 58 feet long, 13 feet wide and 8 feet high. Fine white enamel brick are used in its construction, giving it a fine appearance. The side nearest the generators is smooth, unbroken enameled brickwork, while the side opposite the generators has ten doors of white pine with square windows of heavy plate glass opening into the foundation, where are mounted the heavy main switches and cables. The switchboard and foundation stand just over the subway, which contains the conductors leading to the transformer house. A metallic staircase leads to the gallery of the switchboard, a metallic rail surrounds the foundation, and the floor of the gallery is constructed of slate. The only foreign measuring instruments to be used, it is said, will be some wattmeters, while the voltmeters, ammeters and other measuring instruments will be furnished by the Weston Instrument Company, of Newark, N. J., and the Westinghouse Electric and Manufacturing Company of Pittsburgh, Pa.

The 5,000-hp Alternators.—The 5,000 horse-power alternators are now being placed upon their foundations in the power house. The wheel-pit is arched over to form the floor of the power house, and a cement floor has been laid thereon; the ends of the vertical shafts may be seen in illustration Fig. 3. The first generator being set up is the one nearest the main entrance, the foundation base of which is seen in the foreground of Fig. 1. The alternator shown erected will be the last of the three to be set up, but in the position given shows the other foundations and governors to better advantage.

The two circular cast iron bases mounted upon the stone foundation shown in Fig. 1 are ready to receive the stationary armature, which is bolted to a vertical cast iron cylinder. The mechanical construction of these alternators is practically the same as designed by Prof. Forbes, but the electrical work and details of winding are said to have been modified by the engineers of the Westinghouse Electric and Manufacturing Company. The wrought steel ring, upon which is bolted the inwardly projectng cast iron magnet pole pieces, forms a massive fly-wheel field magnet, and is attached to the vertical shaft of the turbine by a large steel spider. The shaft supporting the rotating fly-wheel field magnet has its bearings supported by the cylindrical frame on which the stationary armature

FIG. 4.—SUBWAY UNDER CONSTRUCTION.

rests. The bronze bushings of the bearings are provided with means for oil lubrication and for cooling by allowing water to pass through an outer chamber when necessary. The highest grade of mica insulation is used throughout the windings of the armature, which consist of copper bars placed in the holes of the armature core. There are two separate circuits from each dynamo, a pair of cables conducting the current for each circuit through a conduit in the cement flooring to the switchboard which stands over the subway that runs the full length of the power house. The alternators, which are 13½ feet high each generate two alternating currents differing in phase from each other by 90 degrees with a frequency of 25 periods per second. The current conducted through each circuit is designed to be 775 amperes at a potential of 2,250 volts. The field coils consist of bent copper bars which receive the current from rotary transformers by means of brushes and copper rings fixed to the shaft which supports the field magnets. The speed of the revolving field magnets is 250 revolutions per minute, and the turbine is said to be so designed that the maximum speed possible will be less than 500 revolutions per minute.

The Roiary Transformers.—The direct current for exciting the field magnets of the alternators as well as that utilized in lighting the building and wheel-pit, and driving the motors for the elevator,

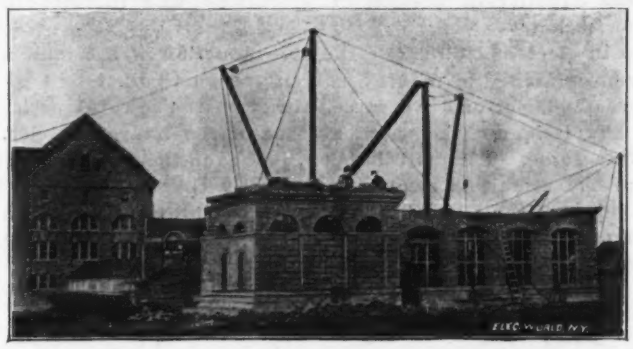


FIG. 5.—VIEW OF POWER HOUSE, CONDUCTOR BRIDGE AND TRANSFORMER HOUSE.

crane, and gate-gearing will ultimately be supplied by rotary transformers located at the further end of the power house near the end of the switchboard and directly over the subway. The rotary transformers were designed by the Westinghouse Company and are each of 200-kw. capacity. These machines are of the six-pole type and deliver a direct current at 220 volts potential. Four stationary step-down transformers will also be used in this connection and will be erected in the subway just beyond the rotary transformers at the end of the switchboard. Two of these stationary transformers will be used for supplying current while the other two are held in reserve. The exciting current delivered by these rotary transformers is conducted from the subway under the switchboard to the dynamo base through a conduit in the floor of the power house, and thence to the brushes of the alternator through the upright iron columns which support the gallery or platform of the generator. The upright columns in the sketch Fig. 2, are not in the correct position, but should be shown directly in front of the alternator and next to the governor, but the sketch as shown gives a better view of the platform and upright columns than it otherwise would. Beneath the floor of the power house a pit is being constructed about 6 feet deep and 18 feet long and 12 feet wide, directly in front of the switchboard, and opening into the subway under the switchboard by a small archway. Into this pit the necessary resistance will be placed, and the conductors leading to it will be carried through the subway.

The Transformer House.—The transformer house was constructed to hold all of the transformers for the total 100,000 hp, and is nearly completed. The transformer house is now occupied by cars loaded with parts of the alternators, including the top casting, field magnet coils and cast iron cylinders for supporting the stationary armature. A car of cables is also standing in the transformer house ready to be laid in the subway (shown in Fig. 4 during construction), connecting the Pittsburgh Reduction Company's works with the transformer house and switchboard. These cables were furnished by the General Electric Company. The current for the Pittsburgh Reduction Company will be transformed at the company's works, and therefore, no transformation of this current will be made in the power company's new transformer house. The stationary transformers, bus bars, and switchboard of the Pittsburgh Reduction Company are said to be rapidly being placed in position, and that the company will soon be in a position to receive the current from the first alternator operated at the power house.

The current from the alternators will be a two-phase alternating current, and four conductors will be necessary to carry the current from the generator to the switchboard and transformer house in two circuits. It is understood that instead of utilizing the two-phase current throughout, as was first planned, it may be decided, if it has not been already, to change the current at the transfomers from a two-phase to a three-phase current; in which case three conductors will be employed instead of four.

Electrical Consonance.

BY M. I. PUPIN.

The question has often been asked whether there is any difference between neutralization of self-induction by capacity and resonance. A similar question is invariably put by young students when they first attempt to grasp the distinction between consonance and resonance in the case of sound. Consonance means strengthening of sound emitted by a vibrating body by connecting this vibrating body to a sounding-board, as for instance, when a tuning fork is put upon a table. Resonance means equality of periods of vibrations, and therefore synchronization.

So in electrical circuits; the self-induction of a circuit may be neutralized and a large current produced in it by a given impressed electromotive force, although the natural period of the circuit is not the same as that of the impressed electromotive force. This will happen, just as in the case of sound, when the circuit is electromagnetically connected to another secondary circuit capable of electrical vibrations. The name *electrical consonance* might well be applied to phenomena of this class. I propose to discuss a case of this kind:

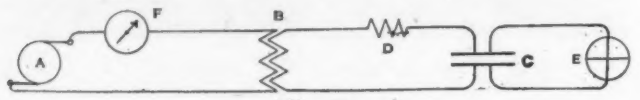


Fig. 1.

In Fig. 1 let A be an alternator, B a transformer, C a condenser in series with the secondary of the transformer, and D an inertia coil of adjustable self-induction. F is an electrodynamometer, and E is an electrostatic voltmeter.

Let L be the self-induction of the primary circuit.

Let R be the resistance of the primary circuit.

Let N and S be the corresponding quantities of the secondary circuit; let, finally, C be the capacity of the condenser.

Denoting now by x and y the primary and the secondary current, respectively, we shall have by the generalized form of Ohm's law:—

$$L\frac{dx}{dt}+M\frac{dy}{dt}+Rx=E\sin pt$$

$$N\frac{dy}{dt}+M\frac{dx}{dt}+Sy+P=O$$

where P is the potential difference of the condenser at any moment.

By elimation we obtain

$$\left(LN-M^2\right)\frac{d^3x}{dt^3}+\left(RN+SL\right)\frac{d^2x}{dt^2}+\left(RS+\frac{L}{C}\right)\frac{dx}{dt}+\frac{R}{C}x=$$

$$=p^2\left(\frac{1}{p^2C}-N\right)E\sin pt+pSE\cos pt$$

Hence the solution

$$x=\frac{E}{\sqrt{p^2L_1^2+R_1^2}}\sin(pt-\phi)$$

$$\text{Where } L^1=L+\frac{p^2M^2\left(\frac{1}{p^2C}-N\right)}{p^2\left(\frac{1}{p^2C}-N\right)^2+S^2}$$

$$R^1=R+\frac{p^2M^2S}{p^2\left(\frac{1}{p^2C}-N\right)^2+S^2}$$

$$\text{Tan }\phi=-\frac{pL'}{R'}$$

The zero value of the phase difference of x evidently when L', the apparent self-induction of the primary circuit, is zero. We shall have then:

$$x=\frac{E}{R'}\sin pt$$

To obtain this neutralization of the apparent self-induction of the primary circuit, we can vary any one of the four quantities, viz: L, p, C N. If, however, for a given periodic speed p

$$\frac{1}{p^2C}-N>0$$

then no value of L will reduce L' to zero for that speed. Then either C or N must vary.

The values of C and N which will reduce L' to zero, can be determined as follows:

$$\text{Let } \frac{1}{p^2C}-N=Z.$$

$$L'=o \text{ when } L+\frac{p^2M^2Z}{p^2Z^2+S^2}=0$$

$$\text{or } Z=-\frac{1}{2pL}\left\{pM^2\pm\sqrt{p^2M^4-4L^2S^2}\right\}=\frac{1}{p^2C}-N$$

Hence, for a given frequency, primary co-efficient of self-induction, and secondary resistance there are two values of the capacity and also two values of the secondary co-efficient of self-induction at which the apparent co-efficient of self-induction of the primary circuit will be neutralized. A case may arise, however, in which no value of C or N can reduce L' to zero. This will evidently take place when

$$p^2M^4<4L^2S^2$$

for in this case the expression for

$$\frac{1}{p^2C}-N \text{ becomes imaginary.}$$

It will also be readily seen that for given values of the electrical constants of the two electromagnetically connected circuits there will be two frequencies at which L' will be equal to zero. For from the relation

$$L+\frac{p^2M^2\left(\frac{1}{p^2C}-N\right)}{p^2\left(\frac{1}{p^2C}-N\right)^2+S^2}=O$$

We obtain

$$p^4-\frac{2LN-M^2-LSC}{NC(LN-M^2)}p^2=-\frac{L}{NC^2(LN-M^2)}$$

$$\therefore p^2=\frac{2LN-M^2-LSC\pm\sqrt{(2LN-M^2-LSC)^2-4LN(LN-M^2)}}{2NC(LN\pm M^2)}$$

Hence there are two distinct frequencies at which the apparent inductance of the primary circuit will vanish. It is plain, however, that the electrical constants of the two circuits may have such values that the neutralization of the primary inductance will be impossible at any frequency.

These considerations show, first, that the neutralization of the *apparent inductance* of a circuit has nothing whatever to do with resonance or synchronization, and secondly, that the experimental adjustments necessary to produce this neutralization are very much more difficult and uncertain than the adjustments necessary to produce electrical resonance. This explains why this phenomenon has not received that attention which at first glance it would seem to merit.

It is interesting and instructive to examine carefully the two values of the secondary apparent self-induction which will neutralize the apparent self-induction of the primary circuit. We have seen that at the point of neutralization x is given by:

$$x=\frac{E}{R'}\sin pt$$

$$\text{Where } R'=R+p^2\frac{p^2M^2S}{\left(\frac{1}{p^2C}-N\right)^2+S^2}$$

$$\text{But since } L=-\frac{p^2M^2}{p^2\left(\frac{1}{p^2C}-N\right)^2+S^2}\left(\frac{1}{p^2C}-N\right)$$

we can also write

$$R'=R-\frac{LS}{\left(\frac{1}{p^2C}-N\right)}$$

Hence, since $\left(\frac{1}{p^2C}-N\right)$ can have two values for which $L'=o$ we shall also have two values of R' and therefore, the current x can have two values when the primary apparent self-induction is neutralized. Denoting these two values by subscripts we shall have

$$x_1=\frac{E}{R+\frac{2pL^2S}{pM^2+\sqrt{p^2M^4-4L^2S^2}}}\sin pt$$

$$x_2=\frac{E}{R+\frac{2pL^2S}{pM^2-\sqrt{p^2M^4-4L^2S^2}}}\sin pt$$

These two values of the primary current can and will gener-

ally differ considerably. For it is possible, theoretically, at least, to make x_1 as many times as large as x_2 as we choose. So, for instance, by making $pM^2-\sqrt{p^2M^4-4L^2S^2}$ very small x_2 will become very small indeed, whereas x_1 may be very large if we choose to take the trouble to make it so.

A numerical example will assist one to see this interesting relation more clearly. Let

$N=1$ Henry.
$M=.5$ "
$L=2$ "
$S=20$ ohms.
$R=50$ "
$p=2$ $\pi\times 110=700$ (very nearly)

The capacities in the secondary circuit at which the apparent self-induction of the primary circuit is neutralized will be

$C_1=2.3$ microfarads.
$C_2=2.03$ microfarads.

There is only about 12 per cent. difference in the two capacities. But if we examine the corresponding apparent resistances of the primary circuit we find

$R'_1=358$ ohms.
$R'_2=5945$ "

Hence, the ratio of the two possible currents in the primary circuit when its inductance is zero will be 1 : 16.6 (about).

We see, then, that the neutralization of the inductance does not necessarily increase the primary current. On the contrary, it may diminish it very much and it will do that whenever this neutralization increases the impedance of the primary circuit. In fact, a moment's reflection will convince us that the physical meaning of the existence of the two values for each the secondary self-induction, the capacity, and the frequency each of which will neutralize the primary reactance is simply this. One value will make the primary impedance a maximum and the other will make it a minimum.

There is, therefore, a radical difference between the following two distinct methods of neutralizing the self-induction of a circuit by means of a capacity. The first method consists in placing the condenser in *direct* connection with the self-induction which is to be neutralized. It gives the circuit a definite periodicity, and neutralization takes place at the point of resonance or synchronism. The capacity acts upon the self-induction alone and upon nothing else. The second method consists in placing the condenser in a secondary circuit, so that its capacity acts *indirectly* upon the self-induction which is to be neutralized. It modifies, however, not only the self-induction but also the resistance of the circuit, so that although it may sometimes reduce the reactance it will not always reduce the impedance, but on the contrary, it may increase it very much. The neutralization does not take place at the point of resonance or synchronization; and it is quite natural that it should not; for a circuit which has no direct connection to a capacity can no more have a definite period of oscillation than a body can have which is devoid of elasticity, and in the absence of such a period there can be no resonance effects. It is, therefore, not at all surprising that for any given values for the electrical constants of the circuit and its secondary there should be two frequencies, if there is any at all, at which the reactance of the primary circuit is reduced to zero. *One frequency, however, will give the minimum and the other the maximum impedance.*

The following experimental method was employed for the purpose of testing the validity of the theory just given.

An alternating current of 133 p. p. s. was sent through the primary turns (No. 12 B. & S.) of a small hedgehog transformer *B*. (Fig. 1) The secondary was connected to a coil *D* of adjustable self-induction and to two large condensers *C* in series with each other. The extreme poles of the condenser battery were connected to a Thomson electrostatic voltmeter *E*. A Siemens electrodynamometer *F* was employed to measure the primary current. The capacity was gradually varied and for each particular capacity the primary current and the difference of potential in the condenser were read and recorded. The following table records the results of one of the series of these experiments.

The rise of the primary current is gradual just as the theory indicates it. I have not been able to produce a very large increase, although I have taken considerable pains to do it. The capacity at which the primary impedance is reduced to a minimum is always greater than the one at which the impedance is made a maximum. Both these capacities are always greater than the capacity which produces resonance in the secondary circuit. The two capacities can be made to approach each other as near as we choose to make them. When $p^2M^2=4L^2S^2$ then the two capacities coincide. In this case, however, there is neither

Capacity in Microfarads.	Primary Current.	Difference of Potential in the Condenser.
4.94	11.3	Below the lowest reading.
4.36	11.4	" "
3.68	11.45	" "
3.10	12.00	" "
2.48	11.95	" "
2.12	11.6	" "
1.96	11.2	500
1.49	9.5	925
1.19	2.5	1,135
.48	6.5	Below the lowest reading.

a maximum nor a minimum in the impedance when the phase difference of the primary current is reduced to zero by the variation of the capacity. As a rule the capacity which makes the impedance a maximum is near the capacity which produces resonance in the secondary circuit. Such a case is illustrated in the table given above.

This class of capacity effects does not present those very interesting features which electrical resonance presents. I have observed them several years ago, but failing to detect in them any purely scientific interest or technical importance I have never paid very much attention to them. This brief note, however, seemed necessary in order to draw a clear distinction between them and electrical resonance. As a phase-changing device this method of modifying the reactance of a primary circuit by a condenser in the secondary will no doubt do very good service some time, especially in the case of high tension primary circuit where a direct introduction of condensers into the circuit would be neither advisable nor perhaps very effective.

Crude Petroleum as Fuel.

In the paper read by Mr. A. M. Hunt before the Technical Society of the Pacific Coast, the subject of the use of crude petroleum as a fuel is very thoroughly considered.

Mr. Hunt describes the various methods of burning fuel oil, which are as follows: First, by hearth fires where the oil is burned in open pans or on plates, or in drops from small pipes and which spread over the bottom of a furnace. The bottom of the furnace may be covered with some porous non-combustible substance, itself being saturated with the oil, which is fed from a tank by gravity. This method is condemned. Second, where the fuel comes into the furnace as a gas, being vaporized in a supply pipe. This method is stated to have fallen into disuse. Third, by spray burners which inject oil into the furnaces as a spray or in fine jets, or by means of steam or air. A vast number of such burners have been devised, and a number are in successful use.

The burner used at the Midwinter Fair consisted of a central tube about one-eighth of an inch in diameter through which the oil passed, its flow being regulated by a stop cock. The steam by means of spiral grooves was given a rotary motion and passed out at the tip in a cylindrical sheath inclosing the jet of oil, catching and spraying it into the furnace; the construction is such that the oil tube can be made to discharge at the same point as the steam, or as much as an inch in advance of it, an adjustment enabling the flame to be focussed or sprayed as may be desired. The author has had a burner made similar to the one described, but with the oil issuing in a hollow sheath with a jet of air inside of the sheath, and a surrounding envelope of steam, as above. This should be equally as capable of adjustment as the previous one and use less steam. In thus using oil it should be thoroughly broken up and atomized in order to insure perfect combustion, and that burner is the best which accomplishes this result with the least amount of steam and air, and at the same time is not likely to be disarranged and is capable of being easily cleaned out. A number of small burners are better than one or two large ones, as in the former the oil can be better atomized, the flame better distributed and, when the boiler is doing a small amount of work, better service can be had from one or more of the small burners operated at normal capacity than from one large burner throttled down.

It is further desirable to have the air for the combustion heated before admittance to the burner, not only on account of economy but to prevent the deposit of asphaltum, which is apt otherwise to take place in front of or below the burner tip. In some cases the oil is also heated before entering the burner.

At the Midwinter Fair the best results were always obtained by so

manipulating the burner with the air full on as to get a blue Bunsen-burner-light flame and then adjusting the admittance of steam and air until a tinge of luminosity began to show, chasing through the furnace in waves. Under such conditions the carbon in the oil is entirely consumed and the air supply limited to the point necessary for its combustion. After the furnace once becomes thoroughly heated, there should be absolutely no evidence of smoke issuing from the chimney. Care should be taken that the flame does not impinge directly against the iron of the boiler, as overheating of the metal might result.

Thorough tests were made at the Midwinter Fair to determine the efficiency of oil as a fuel, and the average result was that 14.2 pounds of water were evaporated from and at 212 degrees F. per pound of oil, the highest evaporation of any test being 15.13 pounds.

Mr. Hunt remarks that it is a very common thing to hear oil men say that they have obtained an evaporation of 17 or even 18 pounds of water per pound of oil. He states that the theoretical evaporation of oil is about 20.7 pounds to one. An evaporation of 18 to one would indicate a boiler efficiency of 87 per cent., and assuming that the furnace temperature is 400 degrees F. the temperature of the issuing gas would be 312 degrees; if the temperature of the issuing gas were 450 degrees, as would be more probable on the above assumption, the furnace temperature would be 3,461 degrees, an excessive amount.

Mr. Hunt gives a table showing the equivalent prices of oil and coal. A third column is added which takes into consideration the various economies that attend the use of oil, resulting from the fact that there are no coal and ashes to handle, and that boiler repairs are less. The calculation is based upon the assumption that a good burner should not use more than 3 per cent. of the steam furnished by the boiler, and that the weight of a barrel of oil is 310 pounds. The comparison is made with Carbon Hill coal on a basis of an evaporation of 7.6 pounds of water per pound of oil.

Oil per barrel at	Coal per ton at	All economies considered. Coal per ton at
$1.00	$3.66	$3.30
1.10	4.03	3.62
1.20	4.40	3.95
1.30	4.77	4.29
1.40	5.14	4.61
1.50	5.51	4.94
1.60	5.87	5.27
1.70	6.23	5.61
1.80	6.59	5.94
1.90	6.95	6.27
2.00	7.21	6.60

The Electric Light in the Church.

Recently, says London *Lightning*, there was an eclipse of the electric light at Elm Road Baptist Chapel, Southsea, and curiously enough, the pastor had chosen for his texts: Proverbs lxxiv., 20—"The candle of the wicked shall be put out," and Psalm xvii., 28—"For Thou wilt light my candle; the Lord my God will enlighten my darkness," a combination rather cruel to the electric light, for when the lights went out some of the congregation went out also, and obtained candles and lamps, whereupon service proceeded. The pastor could not conveniently change his texts, in consequence of what had happened, and he may have been prepared for the general titter which followed their announcement. Lately a somewhat similar case occurred in an American church, and the amusement was heightened by the action of a deacon who absent-mindedly lighted a match and applied it to one of the electric lamps.

Electrical vs. Sentimental Attraction.

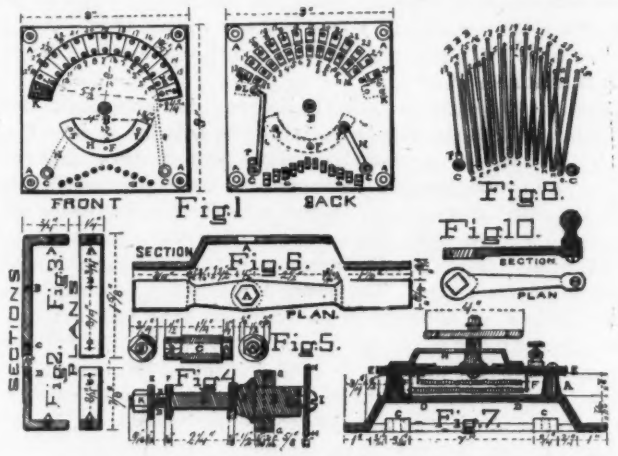
An analogy used by Prof. J. A. Fleming in a lecture to explain the theory of an electrolytic cell was, says London *Lightning*, particularly happy. "Imagine," he said, "a ball-room full of ladies and gentlemen dancing together, but frequently changing partners. Suppose that at one end of the room there is something especially attractive to ladies, and, at the other, something especially attractive to gentlemen; then at each change a gentleman would take a partner nearer the end of the room to which he was attracted, and so with the ladies. Ultimately all the gentlemen would be found at one end of the room and all the ladies at the other." It was part of the professor's case, *Lightning* adds, that the ladies and gentlemen should be mutually attracted to one another, but that the ends of the room should have a still greater attraction for them, and that what attracted the one sex should repel the other. He prudently forbore to press the analogy further. Our contemporary thinks that some of its readers, less gallant than the professor, may be tempted to fill up the hiatus, and suggest what might be found at the two sides of the ball-room.

How to Build a Rheostat—For Amateurs.

BY G. E. DUNTON.

A very simple and efficient rheostat may be constructed at a very small outlay as follows: The back or base shown in section, Fig. 7, and in the illustration, is cast iron. The pattern is easily made of ¼ inch pine stuff. It will not need to be halved, as it will draw out of the sand in one piece. It is 12 inches square over all, 4¾ inches deep, including studs. The stud on each corner (to hold the slate front) is 2 inches long, 1 inch in diameter at the bottom, ⅝ inch at the top, cast into the base. Each is drilled in its end and tapped to receive a "14-20" machine screw. The four bosses on the side rims at the back are drilled with ¼ inch holes.

For the front, procure two pieces of the thickest ordinary roofing slate, that will square up to 9 inches. It can be sawed with an old hand (rip) saw. In each corner drill ¼ inch holes, in 1 inch from the end and side, Fig. 1 A, front. Cut four thicknesses of asbestos paper 9 inches square; lay between the two pieces and fasten together temporarily with ¼ inch (short) stove bolts. Select which side shall be the front and smooth down with sandstone and water. Locate the centre and strike the circles for the segments L and H. Fourteen in the upper circle are of copper or brass ⅛ inch stock, are 1¼ inches long, ¾ inch wide at the top and ½ at the bottom. That at the extreme left of the circle, K, is of fibre. Each is drilled and tapped at points D and E for "6-32" screws. The segment H is one circular piece, the same stock, ¾ inch wide, and drilled and tapped the same at points F. 9-64 of an inch holes are drilled through the slate where the holes in the segments will come at the points D, E and F. The segments in the upper circle should not come snug together, but have a space between of at least 1-16 of an inch. Twelve 9-64 inch holes should



DETAILS OF RHEOSTAT.

be now drilled at points G in the shape of a V from the edge of the slate; also one each at C. Carefully drill a ⅜ inch hole through the centre at B. All the foregoing is shown in Fig. 1.

Shape twenty-six brackets out of ⅛ inch brass, as shown in Fig. 3. Drill fourteen of them at A with a 9-64 inch drill and at C only with a 1-16 inch drill. The other twelve are drilled at A and tapped for a "6-32" screw, and 1-16 inch holes are drilled at both points B and C. Twelve shorter brackets (about half the length of these), Fig. 2, are drilled with 9-64 inch holes at A and 1-16 inch holes at D. These are the same stock. All these brackets go on the back of the slate in Fig. 1. Thirteen of the fourteen long ones go on the upper circle as shown at D the screws passing through them and through the slate and thread into the hole tapped in the segment on the front. The remaining long bracket of this fourteen goes under the binding post at P. The short brackets go on the inner side of this same circle, at points E, beginning at the second place from K, numbered 12 (see Fig. 1, back). The other twelve long brackets go on at points G, the screws coming through the front of the slate and threading into them. The stud carrying the follower on its hub is shown in Fig. 4. The base at B is turned ⅜ of an inch in diameter; the shank C is ⅜. D is turned to 5-16 and threaded with a "16" thread. The nut K is tapped out "16-16" to screw on this end. All the washers on this stud are loose fits; that at F is allowed to slide down over the turned part of the shank C. An open coil spring of four or five turns of No. 16 brass spring wire goes in between E and F. This stud goes into the slate at B, Fig. 1, from the front and fastens from the back, with the washer and screw, I and H, Fig.

4. The hub carrying the follower and wheel, shown in Fig. 5, is turned to ¾ inch diameter from round brass, the ends as shown at A and B being shaped by filing. It is drilled through its length with a 25-64 inch hole. The follower itself is made from ⅛ inch sheet brass, shape and sizes as shown in Fig. 6. This fits on over the end A of Fig. 5, the end being swaged out to hold it in place firmly and the surplus metal filed off smooth. If the builder is in with some steam fitter and can secure a 4 or 5-inch wheel off an old steam valve, it will add greatly to the appearance of the rheostat. Otherwise a handle can be shaped from ½ inch brass, 3 inches long, as shown in Fig. 10, and fitted on to the end of B of the hub in Fig. 5. The follower on its hub may be slipped on over the spindle, the washer F put on, then the spring, the washer E and the nut set up in place. There should be spring enough in the coil to hold both ends of the follower down firmly, in order that it shall make good contact with the segments as it slides over them. Two strips of 1-16 inch copper, ½ inch wide, drilled with 9-64 of an inch holes where the screws pass through, connect from C to F at N and from C to L Fig. 1, back.

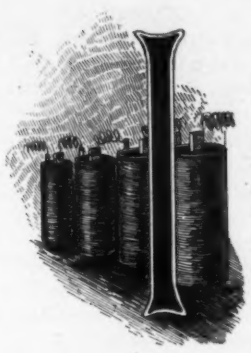
For the resistance coils, German silver wire should be used, if it can be afforded by the builder. Iron wire can be used, but the resistance is only half as great, which lessens the efficiency in that proportion. Two hundred and sixty feet will be needed. Cut this into lengths ten feet and three inches each, making twenty-five lengths. These should be wound up into close coil, spiral springs, over a ⅜ inch arbor, winding very tight; leave about 1½ inch of wire on each end and bend it up at right angles or on a line with

RHEOSTAT AS COMPLETED.

the length of the spring. Before putting the coils in place between the brackets they should be pulled out some, to make them nearly as long as they should be when in position, leaving just spring enough to hold them tight and keep them in place without sagging. The end of the wire on each end of the coil passes through the 1-16 inch holes in the bracket, is pulled up tight, twisted round into the shape of an eye with round-nosed pliers and the surplus snipped off. This holds the coil firmly in position; the two are shown in Fig. 7, F. The plot of the coils is shown in Fig. 8, and is extremely simple and can be easily comprehended by a few moments' study. The two coils connect one segment to the next to it around the series, forming the wire into one long loop of a little over 250 feet. The function of the segments and follower is to switch in or cut out of the circuit more or less of this wire in equal portions as the operator desires. By turning the follower way over onto the fibre segment the circuit through the rheostat may be opened. If it is turned in the other direction to L, all the resistance is cut out and the circuit closed. After the coils are all in place, the slate is put in position on the back or base studs, with a 1-inch iron washer between the studs and slate, then the screws with washers under the heads are set down through the slate and screwed fast into the stud. The binding posts, which are screwed on at C, front, Fig. 1, can be bought at any of the supply stores. The base and wheel should be given a coat or two of good black paint and allowed to dry thoroughly. Make the left hand binding post the positive receiving the current.

Dry Batteries.

BY L. K. BÖHM.



In a certain sense, galvanic batteries may be distinguished as closed circuit batteries and open circuit batteries. Of the first type is required that they give a constant current for a certain length of time, because they are often used for several hours continually without interrupting the current. The typical battery of this kind is the Daniell cell; it consists of a glass jar in which rests a copper cylinder in a solution of sulphate of copper, and a porous cup of clay which acts as a diaphragm, and contains diluted sulphuric acid, wherein is a circular zinc cylinder. Another well known cell which gives a still stronger current than the Daniell is the Grove battery. It contains a zinc cylinder in diluted sulphuric acid and in the porous cup is a thin platinum sheet in concentrated nitric acid. Another battery of this kind is the Bunsen, which is constructed like the Grove, but has carbon in place of the platinum sheet, because carbon is very cheap. These batteries give a constant current for quite a while, but the salt solutions and the acids are exhausted before long and then have to be renewed, and the zinc cylinders are gradually eaten up.

Open Circuit Batteries.—The open circuit batteries on the contrary are quickly exhausted; they decrease in strength considerably if closed for a few minutes only, and they must rest for some time before they come up to the original strength again, therefore these batteries are used where current is needed for a few moments at a time, as for instance in connection with electric bells in houses, where, by touching the button, contact is made and a circuit is closed for a few moments only at a time, while the rest of the time the circuit is open; hence these batteries are termed open circuit batteries. The typical battery of this kind is the Leclanche cell, which consists of a glass jar containing a solution of sal ammoniac, in which is a zinc rod, and a porous cup containing a mixture of carbon and manganese dioxide and a carbon plate. The upper rim of the glass jar and of the porous cup has to be covered with paraffine or grease in order to prevent the creeping up of crystallized sal ammoniac, which would settle all over the glass jar. This battery has been extensively used for operating house and hotel annunciators, electric bells, domestic telegraphs, telephones, burglar alarms, electric clocks, and in electric gas lighting, etc. As the above named uses indicate, the open circuit battery is employed principally in private residences and hotels, and if overturned by accident the sal ammoniac solution will ruin wooden fixtures, carpets, etc., and notably by this deficiency the attention of inventors was turned to the construction of batteries without solutions for open circuit work, that is, to dry batteries.

Historical Dry Batteries.—In the early days of electrical science it was believed that conducting liquids were absolutely necessary for constructing a galvanic battery. Then the crude dry cells were invented, which seemed to prove that no liquids need to be in a galvanic cell. However, moisture at least is necessary for making a galvanic cell operative. This has been proved by Ermann,[1] who placed a dry battery in an artificially dried space and observed that there was no electricity then.

The first dry cell was constructed by Behrens,[2] who used zinc and copper plates, which were separated by gold paper impregnated with table salt. De Luc[3] employed tin, silver and writing paper. Zamboni[4] used artificial silver, paper and manganese dioxide. In those days a dry cell was often constructed of round pieces of paper, which were covered on one side with artificial gold (copper and zinc) and on the other with artificial silver, zinc and tin. The small diameter of these leaves made it possible that thousands of them could be used in a varnished tube, so that a pretty strong battery was obtained. Binding posts were provided at the ends of the tube, so as to allow the connection of the battery tor work.

These crude dry batteries showed plainly the advantages of them in comparison with the wet cells. The absence of solutions in them guarantees absolute cleanliness; glass jars which easily break are not necessary; the cleaning and renewing of the zincs and the refreshing of the solutions is dispensed with, which renders the dry

[1] Ermann, Gilb. Ann., XXV., 1.
[2] Behrens, Gilb. Ann., XVIII., 1.
[3] De Luc, Gilb. Ann. XLIX., 100.
[4] Zamboni, Gilb. Ann., XLIX., 41.—LI., 182.

battery cheaper and more pleasant in use, and prevents disagreeable interruptions while the same are in operation. Although quite a number of dry batteries have been constructed within the last ten years by various inventors, still the dry cell has not received that attention by inventors which has been displayed in other branches of electrical science, and which this subject really deserves.

Modern Dry Batteries.—In the modern dry batteries zinc is generally employed as one electrode, and it is advisable to provide the zinc in the form of a cylindrical case, and to

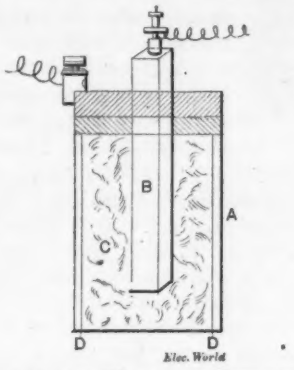


FIG. 1.—PLAIN FORM OF BATTERY.

mount the other parts of the cell therein so that the glass jar is dispensed with. In its plainest form the modern dry battery consists of the zinc case *A*, which acts as the zinc rod in a wet galvanic battery, and is provided at the top with a binding post to which a wire can be attached, a carbon plate *B*, which is generally mounted in the centre of the zinc case without touching its bottom, and which is provided with a second binding post for attaching the second wire; a porous diaphragm or cylinder *D*, between the zinc case and the carbon, made usually of paraffine or wax paper; an excitant *C* around the carbon plate and in the diaphragm cylinder and a seal on the top of wax, pitch or the like. The excitant may contain any salts which are used in wet batteries. Thus it is plainly seen that every one can construct a dry cell for himself; the zinc cases and the carbons are found in the market and only the excitant has to be prepared. The excitants, whose composition is often a trade secret, are generally prepared in a pasty condition. Quite a number of dry batteries have been put on the market within the last decade and some of them will be described further down, when at the same time the components of the excitants will be given. Among the dry batteries which are on the market may be mentioned those of Dr. Gassner, Burndey, Bryan, Koller, Hellesen, Crosby, Hussey, Hewett and "The Mesco" of Harry T., Johnson.

Hellesen's Battery.—Although there is hardly any evolution of gas in dry batteries, still some gas may be formed, and in a hermetically closed battery these gases may force their way through some weak point or even injure the battery, therefore in Hellesen's construction little openings are provided in the top and above the active substances for allowing such gases to escape. Hellesen's battery consists of an outer receptacle *A*, and an inner receptacle *B*, of zinc, the carbon *C*, which is surrounded by a bag *H*, wherein a paste is contained of di-polarizing substances; the space between the bag and the inner walls of *B* is filled up by a thick, slimy matter containing the electrolyte *G*, which causes the electrical

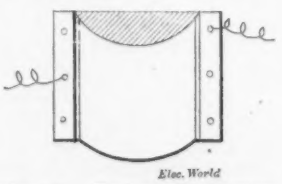


FIG. 2.—BRYAN BATTERY.

excitation. Above the bag a layer *E*, of plaster of paris, or the like, is put in, and on the top is a layer of pitch. The space between the inner and outer receptacle contains sawdust or slag wool. The inner case *B* has two small air holes *a* in the portion where the plaster of paris is. The outer receptacle *A* has two small air holes *d* near the bottom. Any gases arising in the electrolyte *G* will pass through this mass, through the plaster of paris and leave through the hole *a* going through the sawdust or slag wool, and will pass out through the little holes. The carbon is provided at the top with a metal head *C*, in form of a binding post, and the inner receptacle *B* is provided with a wire or binding post, which passes through the pitch, so that the current can be taken off.

Bryan's Battery.—Bryan has invented a battery for especial use in connection with electric belts. It consists of a semi-cylindrical zinc case *A*, which is flat on the inner surface so that it can be fastened on the belt, a carbon plate *B* and an excitant *C*, enveloping the carbon plate *B* inside of the case *A*. A strip of paraffine paper insulates the carbon from the zinc. The excitant consists of sulphate of iron, six parts; bisulphate of mercury, one part, and sulphate of calcium, five parts, all by measure. Water is added to this mixture until the whole is plastic; it dries out in time and hardens. The sulphate of calcium acts merely as a body for the active ingredients of the excitant. The compound forming the excitant may be filled into the case while in a plastic condition. The top through which the excitant is introduced is sealed with wax.

Koller's Battery.—In Koller's dry battery the excitant consists of plates of exciting material in a gelatinous consistency; the diaphragms in the cell are made of perforated sheets of waterproof insulating material, for instance, gutta-percha paper, paraffine paper, or wax paper. In order to prepare these plates agar-agar is boiled in sixteen to thirty times its weight of water until its structure is lost, when six parts of sugar syrup may be added to prevent the drying and shrinking. The mass is evaporated to a desired density, and before it solidifies metallic salts are stirred in there in dry form or as concentrated solution; these salts give the electric excitation in these batteries. Any salts which may be used in a galvanic battery can be employed, except those which prevent agar-agar from coagulation. Sulphate of copper, for instance, will prevent the coagulation if too long in contact with the liquid agar mass. The amount of salts stirred in the agar mass is the same as would be used in a solution for this respective size in a wet battery. The pasty or solid mass, with the excitant salts, are cast

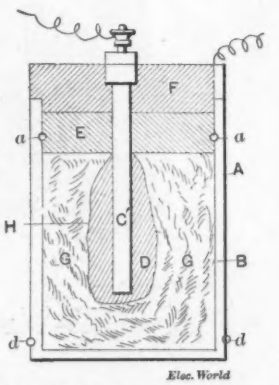


FIG. 3.—HELLESEN BATTERY.

into blocks, these blocks are cut into plates, which are inserted between the plates of the cell, the diaphragms are mounted so that the perforation of one diaphragm stands against the full part of the other. In the sketch *A* is the zinc plate, *B* is an agar plate containing sulphate of zinc; then follow two diaphragms *C* with space *F* between them, then comes an agar plate containing sulphate of copper, then comes a copper plate. The copper and zinc plates are provided with binding posts so that the current can be taken off.

The Efficiency of Dry Cells.—The time which a dry battery will last depends upon the work it is to perform. For ordinary call bell or burglar alarm service it will last from one to two years. It is asserted that a dry battery rang an electric bell for over two hundred hours without interruption, a result which can hardly be obtained by the use of a Leclanche battery. A primary clock may be driven by a dry battery for over half a year. A primary clock connected with a secondary clock can be driven by three batteries for over nine months without being stopped for a moment. The electromotive force of dry batteries varies from 1.30 to 1.50 volts. Prof. Eric Gerard, at the Electro Technical Institute in Liege, Belgium, found 1.44 volts E. M. F. and 0.32 ohms internal resistance. The amperage varies according to size; some show six to eight amperes. The dry batteries are manufactured in various sizes, the outside dimensions of the most used sizes are, height 4¼ to 7⅜ inches, and the diameter is from 2⅞ to 7⅜ inches. For working bells a small cell will answer, while for telephone service a cell 7⅜ inches high and 4⅞ inches wide is generally employed.

Electrical Power Transmission.—XII.

BY LOUIS BELL, PH. D.

On long lines, the direct current has the advantage of producing no inductance in the line, an advantage, however, which does not apply to plants of voltage such as would be ordinarily used on long lines, and which, therefore, can advantageously be operated only as single units. Such a single unit system, arranged for alternating currents, can have the inductance of the circuit completely nullified by the simple expedient of strengthening the field of the motor. In plants of moderate voltage, involving distribution of power, and in such plants only, does this property of avoiding inductance become of any value, and we shall see later that even here the advantage is more nominal than real, on account of the trifling inductance found in alternating lines up to a distance at which direct current distribution would become inadvisable on account of limited voltage. In cases of distribution direct current voltages of over 1,000 volts are nearly impracticable on account of the difficulty of winding motors of moderate size for more than this voltage. If the number of units be considerable, the three wire system affords some relief in this particular. When, therefore, distances of several miles are to be covered and power is to be distributed, direct current is at a disadvantage by reason of the available voltage, which compels a considerable lowering of the efficiency of the system, or a very great increase in the amount of copper.

It must be remembered, however, that in several particulars direct current has peculiar advantages. In the first place, it must be admitted that a direct current is decidedly less dangerous than an alternating current of the same nominal voltage, so far as the question of life is concerned. The difference between the two is probably even greater than would be indicated by the difference in maximum voltage. An alternating current has a maximum voltage of approximately 1.4 times its mean effective voltage, and in addition to this an alternating current is certainly intrinsically more dangerous by reason of the greater shock to the nervous system produced by the alternations of E. M. F. The ease of transforming alternating current to a lower voltage partially obviates this objection, but the fact remains. So far as dangers of fire are concerned, the direct current has the power of maintaining a much more formidable arc than an alternating current of the same effective voltage; but, on the other hand, the alternating current has somewhat greater maximum voltage with which to start the arc, so that, practically, honors are even. It is a mistake, however, to suppose that the increased maximum voltage in an alternating current embodies greater danger of leaking, or breaking down insulation under all circumstances. Under many conditions it is highly probable that the electrolytic strain from direct current on insulating materials, particularly when damp, may be more destructive than the added electrostatic strain of an alternating current. Within any voltages now employed, the total difference is probably immaterial. In the matter of one of the great dangers to an overhead line and apparatus, *i. e.*, injury from lightning, direct current has a very material advantage in that it is possible to use coils of considerable self-induction in connection with such circuits, so as to keep oscillatory discharges, like lightning, out of the machines. This is well shown in the singular freedom of arc lighting stations from serious damages to the machines by lightning, as compared with stations containing other kinds of electrical apparatus. In this case the magnets of the arc machines themselves act as a powerful inductance, tending to throw the lightning to earth. High voltage, shunt wound dynamos and alternators are much more sensitive in this respect. As a consequence, part of the price one has to pay for the privilege of utilizing alternating currents is extra care with respect to protective devices against lightning. In the present state of the art, the best field for transmission and distribution of power by direct currents is in problems involving distribution over moderate distances, within, say, a couple of miles from the centre of distribution, and even then in problems where lighting is not an essential part of the work. The voltage of lighting circuits is determined by the voltage of the lamps which can be employed upon it, and this is so limited that if lighting is to be done on the same circuit as power distribution there are very few cases where such a combined system can be successfully used.

At all long distances direct current is at a disadvantage in the matter of available voltage where distribution is employed, and has no very material advantages for single unit work. Nothing short of a revolution in the art of making commutators can render the direct current thoroughly available for high voltages, and even then only in fairly large units. In this lies its weakness. Its strength is largely in its present firm foothold in electrical practice, and the fact that standard apparatus of this kind is available everywhere and is manufactured in large quantities by numerous makers. It is, furthermore, interchangeable to a degree which will never be true of alternating current machinery until there is far greater unity in alternating current practice than we are likely to have for some years to come.

The Line.

The line is the most critical part of a power transmission system, for on its integrity depends the continuity of service without which even the most perfect apparatus is commercially useless. In most cases the customer who uses electrical power neither knows the efficiency of his motor nor cares much about it so long as the machine goes steadily along without the annoyance and expense of frequent repairs. But if the service frequently fails, suspending the operation of all his machinery while repairs are being executed, the electric motor, so far as he is concerned, is a commercial failure, and a nuisance to boot, and no representations of cheap power can be of much avail when a single stoppage may cause more loss than could be recompensed by free power for a month.

Modern dynamos and motors of almost every class are reasonably efficient and reliable, so that as a rule the line is the weakest portion of the system. More particularly is this the case when the distance of transmission is great and many miles of line must be guarded, inspected and kept in perfect working order. In such lines not only is the actual labor of maintenance increased, but the principal engineering difficulties will there be encountered. With apparatus of the character even now available, the future of electrical power transmission depends in very large measure on the development that takes place in the construction, insulation and maintenance of the line, together with the solution of certain electrical problems that arise as the line grows longer. It is therefore important to go into the matter very carefully, as regards not only the general arrangements and the electrical details of the work, but with respect to methods of construction.

We may thus with advantage divide our consideration of the line into three heads. First, the line in its general relations to the plant, considering it merely as a conductor. Second, the line as a special problem in engineering. Third, the line as a mechanical structure. Of these heads the first has to do with such questions as the proper proportioning of the line as a part of the system, its function as a distributing conductor, and its bearing on the general efficiency of the plant of which it is a part. Next come up for examination the electrical difficulties that inhere in the line, and finally the materials of construction and the methods of applying them.

One of the first questions that arises in designing a plant for the transmission of power is the character and dimensions of the conducting system in their relation to the rest of the plant. Efficiency is generally the first thing thought of—cost comes as a gloomy afterthought—and between these two service is only too frequently neglected. In taking up a transmission problem the layman's first query generally is, "How much power will be lost in the line?" and when the engineer answers, "As much or as little as you please," the subject of line design is opened up in its broadest aspect.

Whenever an electrical current traverses a conductor there is a necessary loss of energy due to the fact that all substances have an electrical resistance which has to be overcome. The energy so lost is substantially all transformed into heat which goes to raising the temperature of the conductor, and indirectly that of surrounding bodies. The facts in the case are put in their clearest and most compact form by Ohm's law, $C = \frac{E}{R}$. This states that the current is numerically equal to the electromotive force between the points where the current flows, divided by the resistance. Hence, this E. M. F. equals the current multiplied by the resistance between these points.

$$E = CR.$$

This tells us at once the loss in E. M. F. between the ends of any line provided we know the current flowing and the resistance of the line. And inasmuch as the energy transmitted by the same current varies directly with the working E. M. F. a comparison of the loss in volts determined as above, with the initial E. M. F. applied to the circuit, shows the percentage of energy lost in the line. Obviously its absolute amount in watts is equal to the E. M. F. lost, multiplied by the current, *i. e.*, CE, or from the above, C^2R, if we prefer to reckon in terms of the resistance.

(To be continued.)

Practical Notes on Dynamo Calculation.—XXV.

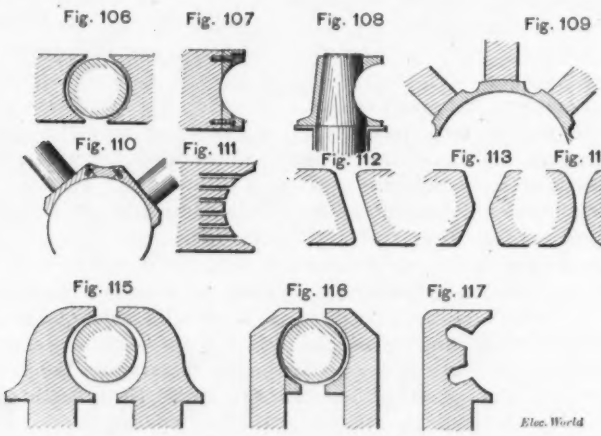
BY ALFRED E. WIENER.

Chapter 44.—Pole Pieces.

(a) Material.

The pole pieces, if the shape and the construction of the magnet frame permits, should be of *wrought iron* or *cast steel* in order to reduce their size, and therefore their magnetic leakage, they being of the highest magnetic potential of any part of the magnetic circuit. In forging, care should be taken that the "grain" or texture of the iron runs in the direction of the lines of force. The pole pieces, however, usually have to embrace from .7 to .8 of the armature surface (compare Chapter 1), and are, therefore, particularly in the case of bipolar machines, often comparatively large. If in such a case their cross section, in order to give sufficient mechanical strength, is to be far in excess of the area needed for the magnetic flux, there is no gain in using wrought iron or cast steel, and the pole pieces should be made of cast iron. The *cast iron* used should be as soft and free from impurities as possible. It is preferable, whenever practicable, to have it annealed, and, if not too large in bulk, to have it converted into malleable iron; this is especially to be recommended for small machines.

An admixture of *aluminium* has been found to increase the permeability of the cast iron; by adding 1½ per cent., by weight, of aluminium, the maximum carrying capacity of the cast iron is increased about 5 per cent., by 3 per cent. admixture it is increased 7 per cent., and by adding 6 per cent. of aluminium, the induction increases about 9 per cent.; above 7 per cent. of admixture, the



Figs. 106 to 117.—Types of Pole Pieces.

permeability decreases, and at 12 per cent. addition of aluminium the gain in magnetic conductivity falls down to 7 per cent. From this it follows that an addition of from 6 to 7 per cent., by weight, of aluminium is the proper admixture for the purpose of improving the magnetic qualities of cast iron, which is explained by the fact that the latter percentage is the limit from which up the hardening influence of the aluminium upon the cast iron becomes appreciable.

In large multipolar machines combination frames consisting of wrought iron magnet cores, cast iron yokes, and cast steel pole pieces, give excellent results, having the advantages of the high permeability and uniformity in the magnetic qualities of the wrought iron, of cheapness of the cast iron, and of reduction in size of the cast steel pole pieces, and being easier to machine, requiring less chipping and being more easily finished than a magnet frame made entirely of cast steel.

A material which a few years ago was quite a favorite with dynamo builders, but which since has to a great extent been displaced by the cheaper cast steel, is the so-called "*Mitis metal*," or *cast wrought iron*, obtained by melting down scrap wrought iron in crucibles and by rendering it fluid by the addition of a small quantity of aluminium. The trouble with this material was that a great many extra precautions had to be taken to procure sound castings, and that as a rule the castings were rough and difficult to work on account of their toughness. The magnetic value of Mitis metal differs very little from that of cast steel, its permeability at the inductions used in practice, being but a trifle lower than that of the latter.

Edges and sharp corners are to be avoided as much as possible, for if they protrude sufficiently they will act to a certain extent as poles and give cause to a source of loss. In castings thin projections are apt to chill while being cast, thus making them quite hard and destroying their magnetic qualities; when necessary for mechanical reasons they should therefore be cast quite thick and massive and may afterwards be planed or turned down to the required size.

(b) Shape.

The pole pieces have for their object the transmission to the armature of the magnetic flux set up by the field magnet, and the establishment of a magnetic field-space around the armature. The shape to be given to them must therefore effect the concentration of the lines of force upon the armature and not their diffusion through the air. This, in general, is achieved by making the polar surfaces as large as possible and bringing them as near to the armature as mechanical considerations permit, and by reducing the leakage areas of the free pole surfaces as much as possible. For practical rules of fixing the distance between the pole corners and the clearance between armature surface and pole pieces for various kinds and sizes of armatures see Tables XLVII. and XLVIII., Chapter 34, respectively.

Since Foucault or eddy currents are produced in all metallic masses, either by their motion through magnetic fields or by variations in the strength of electric currents flowing near them, the pole pieces of a dynamo-electric machine are seats of such currents which form closed circuits of comparatively low resistance and thereby cause undue heating. These currents are strongest where the changes in the intensity of the magnetic field or of the electric current are the greatest and most sudden; this is the case, and consequently the eddy currents are strongest at those corners of the pole pieces from which the armature is moved in its rotation, for owing to the distortion of the magnetic field by the revolving armature a density greater than the average is created at the corners where the armature leaves the pole pieces and a density smaller than the average at the corners where it enters. In order to reduce and eventually to avoid the generation of these eddy currents in the pole pieces as well as in the armature conductors, it is therefore necessary to prevent the crowding of the magnetic lines towards the tips of the pole pieces and to so arrange the poles that the magnetic field does not suddenly fall off at the pole corners, but gradually decreases in strength towards the neutral zone. This object in a smooth armature machine can be attained (1) by gradually increasing the air-gap from the centres of the poles towards the neutral spaces in boring the polar faces to a diameter larger than their least diametrical distance apart, thus giving an *elliptical* shape to the field space as illustrated in Fig. 106; (2) by providing wrought iron pole pieces with *cast iron tips* forming the pole corners and terminating the arcs embraced by the pole faces (see Fig. 107 and 108); or (3) by establishing a magnetic shunt between two neighboring poles in connecting the pole pieces either by a cast iron ring of small sectional area (Dobrowolsky's *pole-bushing*) or by placing thin *bridges* across the neighboring pole corners, as shown in Figs. 109 and 110, respectively.

The *ellipsity* of the field space has the advantage that it confines the lines of force within the sphere of the pole faces by proportionately increasing the reluctance towards the pole corners, thus preventing an increase of the magnetic density at any particular portion of the pole piece. The application of *cast iron pole tips* with wrought iron (or cast steel) pole pieces does not prevent the crowding of the lines at the pole corners, but by reason of the low permeability of the cast iron reduces their density to a figure below that in the wrought iron, and consequently effects a graduation of the field strength near the neutral space, the maximum density being in the wrought iron at the point where the cast iron tips are joined. In the *pole bushing* or its equivalent, the *pole-bridges*, the reach of the magnetic field is greatly increased, the percentage of the polar arc being practically=100, and also a more or less gradual decrease of the field strength at the neutral point is obtained, but the length of the non-sparking space is greatly reduced and thereby its uncertainty increased, thus making the proper setting of the brushes a very difficult operation.

It has also been recommended to *laminate* both the pole pieces and the magnet cores in the direction parallel to the armature shaft in order to prevent the production of eddy currents, but this can only be applied to small dynamos, as the additional cost connected with such a lamination in large machines would be in

no proportion to the small gain obtained. Besides, there is another reason against lamination; a laminated magnet frame is very sensitive to the fluctuations in the load of the machine, which naturally react upon the magnetic field, and in following these fluctuations, an unsteady magnetization is produced, which, in turn, again tends to increase the fluctuations causing its variability; while in a solid magnet frame the eddy currents induced by the changes of magnetization caused by the fluctuations of the load tend to counteract the very changes producing them, and therefore exercise a steadying influence upon the field, thus reducing the fluctuations in the external circuit of the machine.

An expedient sometimes used instead of laminating the pole pieces is to cut narrow longitudinal slots in the pole pieces, Fig. 111, thus laminating a portion of the pole-pieces only. These slots at the same time serve to increase the length of the path traversed by the lines of force set up by the action of the armature current, and to thus reduce the armature reaction upon the magnetic field, checking the sparking connected therewith.

When the commutator brushes, after having short-circuited an armature coil, break this short circuit, the sudden reversal of the current in the same, produced in passing the neutral line of the field, together with the self-induction set up by the extra current on breaking causes a spark to appear at the brushes, which may be considerable, since in the comparatively low resistance of the short-circuited coil a small electromotive force is sufficient to produce a heavy current. If a dynamo, therefore, is otherwise well designed, that is, if the armature is subdivided into a sufficient number of sections, if the field is strong enough so as not to be overpowered by the armature, and if the thickness of the brushes is so chosen as to not short-circuit more than one or two armature sections each simultaneously, and as not to leave one commutator bar before making connection with the next strip, then the sparking at the commutator can be reduced to a practically unappreciable degree by so shaping the pole surfaces as to give a suitable fringe of magnetic field of graduated intensity, thus not only causing the current in the short-circuited coils to die out by degrees, but also compelling the coils to enter the field of opposite polarity gradually. This is achieved by giving the pole corners an *oblique*, or a *double conical*, or a *hyperbolical* form, as illustrated by top views in Figs. 112, 113 and 114, respectively.

For the purpose of counteracting the magnetic pull due to the armature thrust in bipolar machines, see Chapter 24, the pole pieces are often mounted *eccentrically*, leaving a smaller gap space at the side averted from the field coils than at the side towards the same, Fig. 115; or in case of wrought iron or steel pole pieces, *cast iron pole tips* are used at the side towards the exciting coils and wrought-iron or steel tips at the other, Fig. 116. Both the *eccentricity of the pole faces* and the *cast iron pole tips*, if suitably dimensioned, have the effect of increasing the reluctance of the stronger side of the field in the same proportion as the density rises on account of the dissymmetry of the field, thus making the product of density and permeance the same in both halves.

(To be continued.)

Electrodynamic Machinery.—XXV.

BY EDWIN J. HOUSTON AND A. E. KENNELLY.

118. In order to show the application of the foregoing principles to the calculation of the E. M. F. produced in an armature of the Gramme type, we will take the case of a bipolar Gramme wound armature from dimensions given by Messrs. Owen and Skinner in a paper read before the American Institute of Electrical Engineers, May 16, 1894, to which paper the reader is referred for fuller particulars of construction and results.

Fig. 106, reproduced from the paper referred to, shows a vertical and a longitudinal cross-section of the machine, which is a bipolar constant current Gramme-wound generator of the Wood type, intended for the supply of any number of arc lamps in series up to 25, and therefore, capable of supplying a total E. M. F. of approximately 1,200 volts at terminals, with a current strength of approximately 10 amperes and an external activity of about 12 kw.

This machine, when complete, closely resembles the generator shown in Fig. 107. Referring to Fig. 106, the field magnet frame of cast iron is shown at *M*, *M*, *M*, *M*, the field coils being wound on spools and filling the spaces indicated. The shaft of the machine is supported in bearings *B B*, and space is left on the shaft for a commutator at *C*, and a driving pulley at *P'*. The bipolar field poles produced by the M. M. F. of the magnet coils *M*, *M*, *M*, *M*, are shown at *P P*, *P' P'*. The Gramme-wound ring armature is shown at *A A A*. The dimensions of the machine are indicated in inches on the figures.

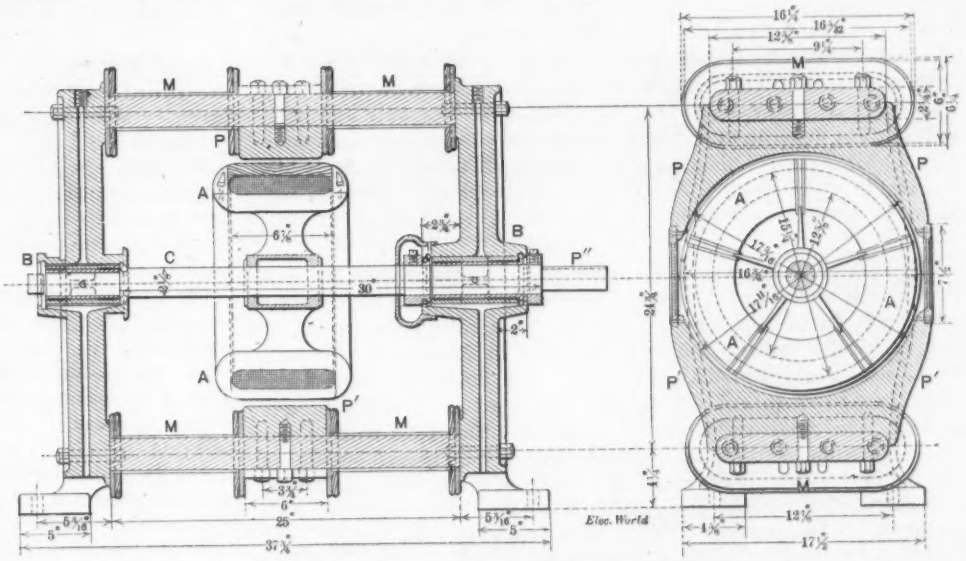


FIG. 106.—GRAMME TYPE ARC MACHINE.

119. The field winding consists of 100 lbs. of No. 10 B. & S. gauge, single cotton-covered copper wire, the total resistance of the four coils in series being 15.75 ohms hot. The armature core is composed of soft charcoal iron wire of the cross-section shown. It is wound in 15 layers of No. 10 B. & S. gauge, and contains about 9,450 wires, each having a cross-section of 0.00817 square inches, or a total cross-section of 77.2 square inches = 498.1 square cms. The armature is wound in 100 sections of No. 14 B. & S. gauge, double cotton-covered copper wire, in 57 turns each, or 5,700 turns, making a total of 115 lbs. of wire, with a total resistance of 28.8 ohms hot, but which being connected in two parallel halves, as represented in the figure, has a joint resistance between brushes of 7.2 ohms. Assuming 10 amperes to flow through the machine, the drop in the armature will, therefore, be 72 volts, and the drop in the field magnets 157.5, making the total drop in the machine 229.5. When, therefore, the pressure at the machine terminals is 1,200 volts, the E. M. F. generated by the machine is practically 1,430 volts, or $1{,}430 \times 10^8 = 1.430 \times 10^{11}$ C. G. S. units of E. M. F.

120. The formula for determining the E. M. F. generated by a bipolar armature is

$$E = \Phi\, n\, w \qquad \text{C. G. S. units (Sec. 45).}$$

Consequently, $\phi = \dfrac{E}{n\, w}$.

The speed of this generator is stated to be 1,000 revolutions per minute, or 16.67 revolutions per second, and w is 5,700, therefore, $\Phi = \dfrac{1.43 \times 10^{11}}{16.67 \times 5{,}700} = 1.505 \times 10^6$. The total flux through the armature is, therefore, 1.5 megawebers.

121. Assuming that the M. M. F. required for this machine were not known, it could be calculated in the following way. We first determine the flux density in the various parts of the circuit, and from that the reluctivity and reluctance of the various portions.

The cross-section of the armature core, as already stated, is 498 square cms. and if the flux goes through each side or cross-section of the armature, the intensity in the armature is, therefore, $\dfrac{0.75 \times 10^8}{498} = 15{,}060$ gausses. The arc covered by each pole-piece is approximately 55 cms and the effective breadth 6.5″ = 16.5 cms, so that the area of the polar surface is approximately $55 \times 16.5 = 907.5$ square cms. The total flux passes through this surface, and the

mean intensity in the air gap is $\frac{1.5 \times 10^6}{907.5} = 1,658$ gausses.

122. Fig. 108 represents diagramatically the arrangement of magnetic circuits through the machine, where M, M, M, M, represent the field magnet cores, P P' the pole-pieces and A A the armature. Fig. 109 represents diagramatically the voltaic analogue of

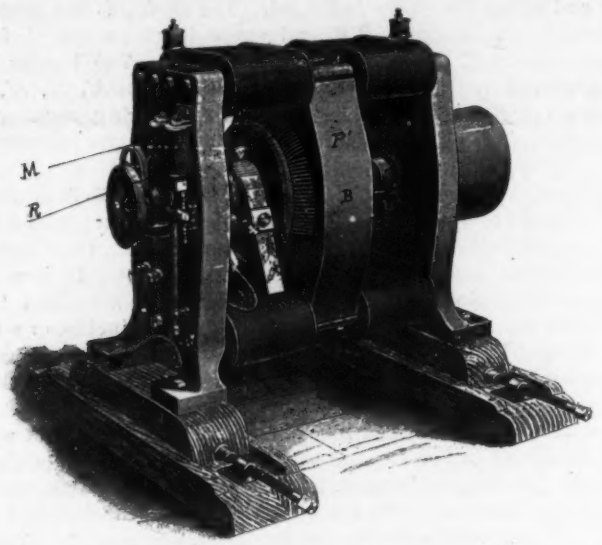
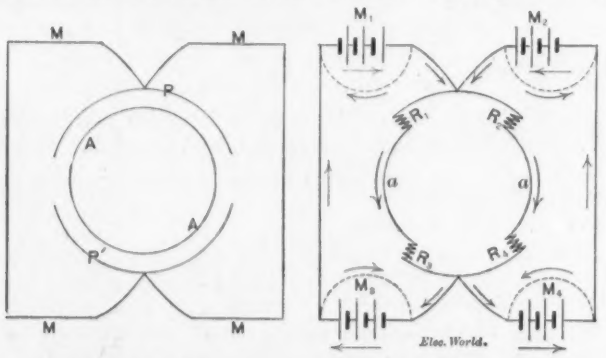


Fig. 107.—Gramme Type Arc Machine.

the magnetic circuits, where M_1 M_2 M_3 M_4 are four batteries, whose E. M. Fs. correspond to the M. M. Fs. of the field magnet coils M^1 and M^3, form one circuit through the field frame, a certain mean length of the pole-pieces and a mean length in the armature a, together with the two resistances R R in the air gaps. A similar circuit is provided for the E. M. Fs. M^2 and M^4, through the air-gap resistances R and R, and the mean lengths of armature and pole-pieces. The equivalent arrangement of circuits is represented in Fig. 110, where M M are E. M. Fs., each equal to M, while the resistance of the double circuit through the field frame is one-half of that of either of the resistances represented in Fig. 109.

The flux through the field cores will be greater than the flux through the armature by reason of a certain leakage which occurs over the surface of the magnetic circuit. This leakage is represented diagramatically in Fig. 109 as taking place in a branch circuit or dotted semi-circle around the field coils, but in reality the leakage takes place in an extended system of branched or derived circuits between the polar surfaces and portions of the entire field frame. The calculation of the various reluctances in the air-path offered to leakage is very complex, and it is preferable rather than to attempt such calculation, to refer to experimental data already acquired with machines of similar type. The leakage factor, or the ratio of total flux through the field magnet cores to the total flux passing from them through the armature, for a machine of this type, is approximately 1.7, so that since the useful flux passing through the armature from each circuit M_1 M_3 and M_2 M_4, Fig. 109, is 0.75



Figs. 108 and 109.—Diagram of Magnetic Circuit and Voltaic Analogue.

megaweber, the flux through the field cores may be taken as $0.75 \times 1.7 = 1\ 275$ megawebers. The cross-section of the cores is found to be 176.8 square cms, so that the intensity in them is approximately $\frac{1.275 \times 10^6}{176.8} = 7,211$ gausses.

123. The reluctivity of the armature, consisting of soft wrought iron at a density of 1.5 kilogausses, is approximately 0.0045 (Fig. 47), the mean length of the flux paths through the armature 38 cms. and the cross section 498 square cms. The reluctance of each side of the armature a (Figs. 109 and 110) is, therefore, $\frac{38 \times 0.0045}{498}$ $= 0.000343$ oersted. The joint reluctance of the armature will, therefore, be 0.00017 oersted, but since the armature does not consist of continuous sheets of iron, but of wires, and the flux has to penetrate from wire to wire downward through small air-gaps, the total effective reluctance of the armature will be approximately 0.001 oersted. The length of the air-gap or entrefer is $1.22'' = 3.1$ cms, and the area as already determined, 907.5 square cms, so that the reluctance in each air-gap will be $\frac{3.1}{907.5} = 0.003416$ oersted, the total reluctance in the air as seen in Fig. 110 will be 0.006832 oersted.

The reluctivity of the cast iron in the field frame at a mean intensity of 7,211 gausses may be taken as 0.009 (Fig. 47). The length of the mean path in the field on each side of the machine is approximately 152.4 cms, and its cross-sectional area 176.8 square cms, so that the reluctance in each half of the field will be approximately $\frac{152.4}{176.8} \times 0.009 = 0.00776$ oersted. The total flux being divided between the two sides of the field, the joint reluctance, as represented in Fig. 110, will be 0.00388 oersted.

The drop of magnetic potential in the reluctance of the armature (Φ R) will be	$1.5 \times 10^6 \times 0.001 = 1,500$
The drop of magnetic potential in the reluctance of the air . .	$1.5 \times 10^6 \times 0.006832 = 10,248$
The drop of magnetic potential in the reluctance of the field .	$2.55 \times 10^6 \times 0.00388 = 9,894$
	21.642

Since one gilbert = 0.7854 ampere-turn, the total M. M. F. in the circuit will have to be 17,000 ampere-turns, or 8,500 ampere-turns on each of the spools M M M M.

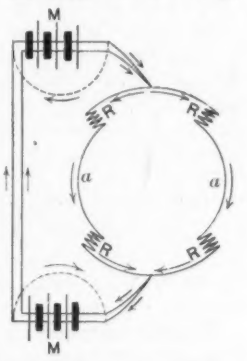


Fig. 110. — Diagram of Voltaic Analogue.

124. The preceding calculation is open to errors from several sources in the absence of definite experimental data, namely:

(1) The assumed leakage factor may be inaccurate.

(2) The mean lengths of the flux paths in various portions of the circuit may be inaccurate.

(3) The assumed increase in the reluctance of the armature due to its being formed of wires instead of solid sheets may be inaccurate.

(4) The reluctivity of the cast iron employed in the machine may not be that of the sample of cast iron assumed.

In this, as in all constant-current machines, means are provided for maintaining a nearly constant current-strength in the circuit despite changes in the load, but a consideration of such means and of the requirements of the magnetic circuit to permit such regulation will preferably be postponed until armature reaction has been studied. (To be continued.)

Laboratory of Houston and Kennelly, Philadelphia.

The Elihu Thomson Prize.

To the Editor of The Electrical World:

Sir:—I notice in your issue of Jan. 26, in giving an account of the "Elihu Thomson prize" in France that you have accorded me more credit than is justly my due. The second sum of 5,000 francs awarded to Dr. Oliver Lodge for his paper was the result of a subscription started by Mr. Ernst Thurnauer in Paris, and to which fund others contributed as well as myself. In fact, the credit of having secured the duplication of the original prize is, I believe, due to Mr. Thurnauer, who, before I knew anything of the matter, had gone to work upon it, with the result which has been announced.

I wish publicly to thank not only Mr. Thurnauer, but also the gentlemen who took such a warm interest in the contest and awarded the prizes, as well as the other subscribers to the second fund. I appreciate your kindly remarks in your editorial dealing with this subject.

Elihu Thomson.

Lynn, Mass.

DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

BY CARL HERING

COMPILED FROM THE PRINCIPAL FOREIGN AND AMERICAN JOURNALS

Note.—The object of this department is to give a digest of the principal technical articles on electrical subjects appearing in American and foreign periodicals. The abstracts will contain, briefly, the nature of the article, its object, and the most important data or conclusions, as far as the limited space will admit. Abstracts made by the authors, editors or publishers are solicited and should be sent to the Philadelphia office of THE ELECTRICAL WORLD, 922 Chestnut street. They should be forwarded so as to be received at least as early as the journal in which the original articles appear; they should not be longer than the importance of the subject warrants, and must comply with the general outline given above, the compiler reserving the right to edit or reject them. Such abstracts may be sent in the English, French or German languages. It will be to the advantage of all concerned if editors of non-electrical journals, or of such electrical journals as are not regularly abstracted, will send the compiler a copy, specially marked, in which any important electrical article appears.

Note.—Owing to the large amount of matter this week some of the abstracts had to be held over until next week.

DYNAMOS, MOTORS AND TRANSFORMERS.

Dynamos Without Commutators.—"L'Eclairage Elec.," Jan. 5, contains a short paper by Mr. Malagoli on the rotating alternating field and its utilization. He discusses alternating revolving vectors and states that "an alternating revolving vector can be considered as the resultant of two constant and equal vectors one revolving to the right and the other to the left and excited besides from another movement of rotation in common to the right or to the left according to the direction of rotation of the revolving alternating vector. One of the vectors being thus excited from two velocities equal and contrary will remain fixed whilst the other turns with a velocity double that of the alternating revolving vector and in the same direction as this one;" a diagram is given to illustrate this. Appyling it to a Gramme ring winding with permanent connections at the end of the diameter and supposing that an alternating field revolves around this ring such that the zero lines coincide with this diameter, he shows that the windings will be the seat of a constant E. M. F. of the same intensity during the whole period; "from that which precedes it easily follows that one could construct a continuous current dynamo having two equal magnetic fields, the one fixed and the other revolving, with separate or with self-excitation, without the use of a Pacinotti commutator but simply with two sliding contacts between which passes the exciting current of a revolving field." He states that it is furthermore possible to apply these results to the construction of a transformer excited by an alternating current which would furnish a continuous current without any revolving part.

Dynamo Without Iron.—Mr. Coerper, in a communication to the "Elek. Zeit.," Jan. 3, states that a number of years ago his company built an 8-hp. dynamo somewhat like that suggested by Mr. Pietzker (see Dig st, Jan. 12), but found that there are no advantages gained.

Design of Large Alternators.—In a brief communication to the Lond. "Elec. Rev.," Jan. 18, Mr. Kennedy in reply to Mr. Armstrong, of Schenectady, states that the London Electrical Supply Company, after many years of experience with coreless disc alternators, have just ordered another one of 1,000 kw, thus confirming his contention that coreless disc dynamos are perfectly successful "and much superior to the horrible designs embodying gigantic rickety masses of laminated iron stampings. * * * * We may look forward to an American inventor in a few years discovering the coreless disc armature, and extolling its virtues, in the same way they discovered the constant current dynamos years after they were abandoned here."

Synchronous Motors.—A mathematical paper of some length by Mr. Steinmetz is published in the "Elek. Zeit.," Jan. 10-17. It does not admit of being abstracted; in the conclusion he gives a numerical example.

Theory and Calculation of Non-synchronous Motors.—A mathematical article by Mr. Legrand is begun in "L'Eclairage Elec.," Jan. 5.

Starting Motors.—In the "Elek. Zeit.," Jan. 10, Mr. Menges discusses the subject, with special reference to the recent article of Mr. Egger (see Digest, Jan. 12), giving, however, nothing new.

The "Western Electrician," Jan. 26, was not received.

First Polyphase Motor.—The article by Prof. Thompson abstracted in the Digest, Feb. 2, is reprinted with the illustration in the "Elec. Rev.," Jan. 30.

Dynamo Design.—In Mr. Harrison's serial in the "Elec. Age," Jan. 26, he discusses the choice of the metals for the field magnets.

Dynamo.—The one with hinged pole pieces described in the Digest, Feb. 2, is illustrated in the "Elec. Rev.," Jan. 30.

LIGHTS AND LIGHTING.

The Electric Arc.—The Lond., "Elec.," Jan. 18, begins the publication of a paper by Mrs. Ayrton in which she will give a very short abstract of the most important points and deductions of the paper by Prof. Ayrton which he read at the Chicago Congress in 1893, the only copy of which was unfortunately destroyed by fire; it will be followed by some later experiments and investigations which she is conducting in the form of a continuation. The paper does not admit of being abstracted, as some of the most valuable information is contained in the form of numerous diagrams and curves, but the following will give an idea of the treatment of the subject. The experiments to which Prof. Ayrton directed his special attention are briefly: "1. Obtaining curves connecting the steady final values of the potential differences between the carbons with the current for different currents, lengths of arc and sizes of carbons, cored and uncored. 2. Obtaining the time variations of the potential difference between the carbons with various constant currents, various constant lengths of arc, and with the ends of the carbons variously shaped. 3. Obtaining the time variation of the potential difference between the carbons when the current was suddenly changed, and the length of the arc was kept constant. 4. The distribution of potential throughout the arc. 5. The influence of varying the current and the length of the arc on the depth and width of the crater. 6. The candle-power and efficiency of the arc, with various currents, potential differences and lengths of arc." The lamp used was hand regulated, an illustration of which is given; the differences of potentials between the carbons was measured by making contacts by means of two thin carbon rods pressing by means of springs against the large carbons near the arc. By the length of the arc is meant the vertical distance between the point of the negative carbon and the horizontal plane drawn through the edge of the crater of the positive, as measured on an image 10 times full size, formed on a screen. The optical arrangements are shown by diagrams; a set of curves are given for the voltage and the current in arcs of various lengths with various sizes of carbons; the voltages were not measured until after the current had been flowing for a considerable time, the length of the arc being kept constant during the whole of this time giving the carbons an opportunity to acquire their normal shape; the time required varied from about 10 minutes to over an hour. The voltage generally falls with increase of current for a constant length of arc; when the positive carbon is cored this is true only for long arcs but for short silent arcs the voltage rises with increase of current; between these two ranges there is a region in which the voltage is practically independent of the current; this particular length is a little less than 2 mm; when both carbons are cored it diminishes to ¾ mm; when both carbons are solid there is no length of silent arc for which the voltage is independent of the current; for very small currents whether one, both, or neither of the carbons are cored the voltage falls rapidly with increase of current. If the voltage is kept constant and the arc lengthened and maintained at this length the current is larger and not smaller than it was for the shorter length. For a constant voltage the apparent resistance of the silent arc when in the normal condition diminishes rapidly as the arc is lengthened; this will be referred to again in describing her own experiments. For very short silent arcs a given voltage will send two distinct currents through the arc, for instance, with 41 volts it will be either 3 or 21 amperes through a 1 mm arc, which indicates a quadratic equation. In the hissing or unstable state no current between the highest for the silent arc and the lowest for the hissing arc can be sent through the arc at all, however cautiously and slowly the resistance in circuit may be varied. The voltage for hissing arcs increases with the length of the arc but appears to be fairly constant for a given length, that is, the apparent resistance varies inversely as the current for a given length. There are two kinds of hissing, a sound like a kettle just about to boil which belongs to a long arc with a small current but which is not accompanied by a drop in the voltage; the other is a sharp hissing of an arc of any length when the current is too great for a silent arc to be maintained; this is the hissing usually referred to; there is a third and several other sounds which are difficult to classify. The idea that a hissing arc is necessarily a short one is dispelled by the curves; hissing may occur with any length of arc if the current is increased beyond what the silent arc can bear.

Arc Lamp.—A lecture by Prof. S. P. Thompson is abstracted in the Lond. "Elec. Rev.," Jan. 18. Numerous experiments with the arc were shown: among other things he dates its discovery back to 1801 instead of 1809; the difference between it and the discharge from an induction coil is that in the former the light comes chiefly from the solid matter of the electrodes and therefore depends greatly on what matter is used, while in the latter it comes mainly from gaseous volatile

particles and not from the solid matter of the electrodes; in a hissing arc there is a large transport of matter but in the silent one it is small; the matter is transported in only one direction, from the positive to the negative carbon.

Projectors.—In the long serial in "L'Eclairage Elec.," Jan. 5 (see Digest, Jan. 12), the authors discuss the influence of the dimensions of the reflector, its focal distance and the intensity of the current, on the lighting power of the reflector.

High Voltage Lamps.—In a communication by Mr. Baynes in the Lond. "Elec. Rev.," Jan. 18, he states that two years ago he recommended the use of 230-volt lamps at the Bradford station; exhaustive tests showed that lamps of two firms ran 3,000 hours without a single breakage, and required an average of 3.2 watts per cp; it was not possible, however, to have any subsequent orders for lamps filled, for which reason the system could not be adopted. In such a system there is a difficulty in dealing with the arc lamps, as no small customer would agree to burn 4 or 5 arcs in series, and it would therefore appear advantageous to use a special circuit for arc lamps in series, metered by a time switch; cheap lamps burning two small arcs in one group might also be used.

Incandescent Lamp Patent.—The Lond. "Elec.," Jan. 18, gives an abstract of the Lane-Fox patent.

Welsbach Light.—The leading editorial in the Lond. "Elec. Rev.," Jan. 18, discusses and criticises very unfavorably the report of the Lancet Commission, which it claims is unsatisfactory and disappointing in many respects and fails to give any support to the expressed admiration; the laudatory terms are somewhat incomprehensible in the face of the figures given. The editorial states that from figures it appears that the Welsbach burner gave the greatest increase of heat per cubic foot of gas burned, the ratio being as 3 to 2; the common burner also gives less carbon dioxide than the Welsbach; "the candle-power estimates and the deductions made from them are hardly worth consideration;" attention is called to the difference between high luminosity and high diffusive power, the latter being what is wanted and the former being of no value; the claims that the quantity of light is greater and the gas bill less cannot both be substantiated, for if one obtains the great increase in light, which is usually the reason for its introduction, the gas bill will remain the same; as the 50-cp is the smallest practicable lamp, there will be an increase of light instead of a reduction of gas; in a fog the Welsbach lights become invisible long before the common gas light is obscured, thus proving their low diffusing power; it believes that a "complete, thorough and unbiased test would reveal very different facts and figures from those given by the rough, brief and unsound investigation made by the Lancet Commissioners."

In the same journal the Welsbach light is defended by Mr. Welch, whose statements are criticised in the above mentioned editorial.

Continuous Current from an Alternating Arc.—Mr. Peirce in the "Elec. Eng.," Jan. 23, offers an explanation for the phenomenon described in the Digest, Jan. 19. The path of a current crossing a magnetic field at an angle will be displaced laterally; if either be reversed the displacement will be reversed; this accounts for the appearance of the flame in both directions. He thinks the unidirectional current is due to the position of the electrodes in the extension of the arc; he believes that if they are very small and placed at the centre of the arc no current would flow through the galvanometer if they are in a plane at right angle to the carbons.

Lantern Projection.—A brief abstract of a recent lecture by Mr. Hopkins is given with illustrations of the lanterns in the "Elec. Eng.," Jan. 30; he showed various applications, among others the projecting microscope magnifying 2,000 to 3,000 diameters with very good lighting.

Electric Lighting in England.—The "Elec. Eng.," Jan. 30, reprints some of the statistics and the map mentioned in the Digest, Jan. 26.

Welsbach Burner.—A paper by Mr. Goetz read at the meeting of the North Western Electrical Association on the "Incandescent Lamp vs. Welsbach Burner" is reprinted in the "Elec. Rev.," Jan. 30, and "West El.," Feb. 2.

Atlanta Exposition.—Some other lighting effects are briefly described in the "Elec. Rev.," Jan. 30.

POWER AND HEAT.

Elastic Couplings for Gas Engines.—In a long communication by Mr. Bablon in "L'Ind. Elec.," Jan. 10, he discusses the subject from a purely practical point of view and argues that if the coupling is sufficiently elastic the irregularities in the speed of the gas engine may always be greatly reduced; he cites the case in which this was done successfully and believes the result would have been even better if the spring coupling had been still more elastic, that is longer; the ideal coupling is one in which the tension does not vary with the length or extension; he believes the irregularities may certainly be reduced to 1-10; with a coupling which is too short the irregularities may be increased as was found by Mr. Picou (see Digest, Sept. 8, see also Oct. 20, Dec. 22 and Feb. 2), but it is theoretically and practically possible to give the coupling sufficient length that the irregularities may be reduced to a small fraction.

Designing Transmission Plants.—A paper by Mr. Mountain on the design and efficiency of plants for the transmission of power by electricity is published with illustrations in the Lond. "Elec. Eng.," Jan. 18; it is elementary in character and appears to be chiefly for non-electrical engineers.

Driving Tools.—See also Crompton's presidential address.

Rock Drills.—In his long serial on mechanical applications Mr. Richard in "L'Eclairage Elec.," Jan. 5, gives well illustrated descriptions of the Siemens & Halske and the Thomson & Houston drills besides other mechanical applications.

Agricultural Applications.—Some estimates showing the advantages of electric power over animal power are given in the "Elek. Zeit.," Jan. 10.

Electric Furnace.—"L'Elec.," Jan. 19, abstracted from the "Chem. News" a description by Mr. Warren of a simple electrical furnace for demonstration purposes for reducing refractory earths, which is used in many large institutions in England; the description is somewhat meagre but it appears to consist of an arc in which the materials are either placed directly or by means of a tube of graphite heated by it. The materials are pulverized and reduced to a paste with a solution of pyroxyline, then moulded into a small rod which is introduced into the arc.

Electric Heating of a Theatre.—According to the Lond. "Elec. Eng.," Jan. 18, the Vaudeville Theatre in London was recently heated electrically and an order has now been given for the permanent warming of the theatre in this way; the cost is not expected to exceed that of other systems.

Electric Heating and Cooling.—See Crompton's presidential address.

Electric Furnace for Heating Iron Strip.—The "Elec. Eng.," Jan. 30, gives a brief illustrated description of the Siemens process (described in the Digest, March 11, 1893) as used in an installation in Montreal for making horseshoe nails. The furnace consists of a carbon tube 24 inches long with a bore of 1 inch and walls ½ in. thick, the outside being enclosed in sand; a current of 500 amperes at 12.5 to 15 volts brings it to a white heat; it is intended for continuous feed and will heat 5 feet of strip per minute; a 1,040-volt alternating current is used and transformed down to the proper amount.

Travelling Shears.—The "West. El.," Feb. 2, publishes an illustration with a brief description of the shears described in the Digest, Oct. 6.

TRACTION.

Accumulator Traction.—The "Elek. Zeit.," Jan. 19, contains a paper by Mr. Feldman describing the Waddell-Entz copper-zinc accumulators which are used on the line which has just been started in Hagen, Germany; the first test was very successful; the line has numerous curves and grades; it is 1.9 miles long; the sharpest curve has a radius of about 50 feet; the steepest grade is 4 per cent., the gauge is 3.28 feet; there are five cars for carrying 26 passengers each having one motor of a maximum of 15 hp; it contains 88 accumulators under the seats, each having 7 negative and 6 positive plates, is 12.6 inches high and 8x4; the weight of the empty cell is 15.4 lbs. and of the field cell 30.8 lbs.; the negative plates are made of a new work of fine iron wire on which the zinc is deposited; the insulators are glass tubes; the plates are placed in sheet steel receptacles; the positive plates are made of copper wire gauze surrounded by finely divided copper and enclosed in cotton bags; they differ from the older form of Comellin and Desmazures in that the dropping of the voltage with strong currents is not so great; the E. M. F. is 0.85 to 0.88 volt, their normal capacity 250 and their maximum 300 ampere-hours, the efficiency being claimed to be independent of the rate of discharge (the ampere-hour and not the watt-hour efficiency is doubtless meant); 3 cells in series were short circuited and gave 400 amperes during 40 minutes, the voltage being still 0.5 and the E. M. F. immediately after opening the circuit 0.85; one charge is intended to run about 20 miles; the weight is about 1.4 tons, the total weight of the loaded car being 70 tons. The field of the motor is excited by a separate set of 12 accumulators which also run the lights, the remaining 76 are either connected in 4 parallel groups or in 2x2 or all in series, there being 8 points on the controller, for the last of which resistances are inserted in the field while at the first one the motors act as a brake charging the accumulators; a car was stopped within one-half to one times its length by means of this brake (the previous speed, however, is not given); on a down grade the charging current is 200 to 300 amperes, but whether this can be used is a question, as the cells must be heated during charge. The charging installation is only briefly described; the cells are in groups of 44 and are placed on steam heat radiators while charging; the charge begins with 0.9 volt and ceases at 1 volt, during which the cells must be heated to about 122 degrees F. It is claimed that for equal output the weight of these as compared with lead accumulators is as 0.55 to 1 and that the life of the plates is not effected by the rate of discharge. Some further information about this type of accumulator will be found under Accumulators.

Wearing Away of the Trolley Wire.—According to the "Elek. Zeit.," Jan. 10, Mr. V. Hefner-Altneck claims that it is not due to electrolysis but to the sparks caused by poor contacts, the sparks carrying particles from the wire to the wheel.

Working of Electric Railways in France.—A translation of the short article mentioned in the Digest, Jan. 5, is published in the Lond. "Elec.," Jan. 18.

Electric Traction System.—"L'Ind. Elec.," Jan 10, extracts from a large work published by the General Electric Company, of Berlin, describing their traction system; 8 large illustrations are reproduced.

Electrolysis of Pipes.—The "St. Ry. Gaz.," Jan. 26, reprints the report of Prof. Barrett (but without the accompanying map) on his investigation of the electrolysis of pipes by escaping railway currents in Brooklyn. Much of it is chiefly of local interest. Extensive measurements were made at 660 street hydrants covering 100 miles of streets, in which the difference of potential between the hydrants and the rail was measured as was also between the hydrant and at least three earth points and between these same earth points and the rail, also in some cases between hydrants and gas pipes and the elevated road structure; he states facts which are now well understood and discusses at some length the distribution of the earth currents as found from his measurements; the dangerous currents are generally near the power station but there are also such points in districts not in the vicinity of the power station. The remedies which he suggests are to keep the currents from the pipes in all those regions where they tend to flow from the rails to the pipes (the trolley wire being positive), by providing a more liberal system of return conductors, to a limit fixed only by considerations of reasonable cost; "after everything that is reasonable has been done in this direction there will still be a large overflow of current from the rails;" the points where the unavoidable residue leaves the pipes should be carefully located and at those points special return wires should be connected to them; this should not be done until an adequate system of outlying returns has been provided for; he thinks that the pipes would then be virtually safe; danger spots will remain to be hunted out and remedies applied to each specific instance, consisting chiefly in electrically connecting different lines of pipes at suitable points and also with the rails. He describes in detail a clamp for making connections with pipes, consisting of a collar, clamping the pipe through a lead gasket. In conclusion he states that at present it is indisputable that the earth currents are causing extensive corrosion in Brooklyn at an indeterminate but serious rate and that there are practical means at command which are being neglected and which if properly applied would largely abate if not altogether arrest the destruction.

Storage Railway and Lighting Plant.—A short paper by Mr. Condict read before the North Western Electrical Association is reprinted in the "St. Ry. Gaz.," Jan. 26. He describes a small plant at Merrill, Wis. in which the combined railway and lighting station was running very unsatisfactorily until after the introduction of a storage battery plant consisting of 240 chloride accumulators with a capacity of 500 ampere-hours at a 50-ampere rate; the batteries are divided into 4 series of sixty cells which can be connected either all in series for the railway, or 2 in parallel for the two sides of the three-wire lighting system; it is charged by means of an independent feeder; it does away entirely with a supplemental steam plant, by the addition of another turbine.

New York Rapid Transit System..—The "Elec. Age," Jan. 26, describes briefly, with an illustration, the Leschziner plans, one of which is to construct a three-deck elevated road through the middle of the blocks and another a depressed road running under private property in the middle of the blocks; he thinks that the cost of the road would not be half that estimated for the proposed roads.

New York Rapid Transit System.—In the "Eng. News," Jan. 31, Mr. Reno gives a more detailed description of his plan including several good illustrations.

Tasmania.—An illustrated description of the Siemens line at Hobart is published in the "Elec. Eng.," Jan. 30.

Series Traction System.—The article by Mr. Perry mentioned in the Digest, Jan. 26, is reprinted in full in the "Elec. Rev.," Jan. 23.

Switch Locomotive.—The "West. El.," Feb. 2, extracts from the Lond. "Railway World" a description of a switch locomotive of 3 tons weight.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Central Stations in Germany.—In a review of the past year, the "Elek. Zeit.," Jan. 3, states among other things that the introduction of the accumulators in central stations in Germany has developed very much in the past year, the application of alternating currents in municipal lighting has also developed and the four following fundamental principles have found almost universal application in the German central stations: moderately low frequency, large units, slow speed, and direct coupling. It is interesting to note that the three-phase current is likely to replace the alternating current in the newer stations, among the reasons being the better utilization of the material in the generators, motors and circuits, and as it is now possible to regulate such systems as easily as the alternating current systems, there is no longer anything standing in the way of its adoption. The application of current for motor purposes has made great progress during the past year; progress in electrical railways has been very promising.

Development of Municipal Stations.—The "Elek. Zeit.," Jan. 10, contains a paper by Mr. Meyer, a brief abstract of which is given in the Lond. "Elec. Eng.," Jan. 18, in which he gives tables showing the lamps connected, the capital, income, expenses and profit of a number of large stations in Germany; the excess of income over expenses, in per cent. of capital invested, varies from a little over 7 in most of them to 15 and even 18. An indirect proof that such stations pay is shown by the willingness of parties to run them at their own expense.

Chemnitz.—The "Elek. Zeit.," Jan. 3, publishes a long and well illustrated description by Mr. Weinhold of this station, in which the three-phase system is used; the machines are coupled in parallel without any difficulty; the apparatus is that of the firm of Siemens & Halske; he gives the curves of the current; the energy is sold for 18c. per kw-hour for lighting and 4.5c. for power purposes.

Cologne.—Detailed data regarding the operation of this station are published in the "Elek. Zeit.," Jan. 10.

London Central Stations.—The Lond. "Elec.," Jan. 18, publishes its annual supplement in the form of a map of London giving in different colors the mains of the various companies up to the beginning of this year.

Cost of Working at the Portsmouth Station.—The Lond. "Elec. Rev.," Jan. 18, gives the results of some examinations regarding the cost of working which it considers are phenomenally good; no meters exist at the works and the current is therefore partially estimated; it believes that the results are without a parallel in corporation lighting; it claims that the cost of generating and distributing is the most startling feature and is as good as anything that has been done in any alternating current station; in the first half of the year of its existence it produced and distributed a kw-hour for 4.6c.

Lighting of Trains.—A brief description of the system used in Denmark (described in the Digest, Sept. 1) is given in "L'Elec.," Jan. 19.

Load Factor.—See Crompton's presidential address.

Chicago.—The "Elec. Eng.," Jan. 23, contains a long and profusely illustrated description of the installation of the Chicago Edison Company by Mr. Martin, including a large double-page plan of the Harrison street station.

Electrical Equipment of the "Priscilla."—The "Elec. Rev.," Jan. 30, gives an illustrated description of the installation on this Fall River Line steamer.

Yarmouth.—The "Elec. Eng.," Jan. 30, reprints the description of the station mentioned in the Digest, Feb. 2.

South Norwalk.—The "Elec. Eng.," Jan. 30, published a short description of this municipal lighting plant, including a table of results giving the consumption of coal, oil, etc., for the past year.

WIRES, WIRING AND CONDUITS.

Explosions in Conduits.—Mr. Gilbert, in the Lond. "Elec. Rev.," Jan. 18, gives his views regarding conduits; he condemns bare conductors; no matter how well made conduits will admit gas and water but they should be constructed as perfectly water tight as possible; it is essential to have side chambers to admit gas and water and that compressed air be sent through the entire system into the manholes once a day; every manhole should be ventilated at the curbstone; the conduits should be made with a cover and the cables laid into them; he gives an illustration of a proposed system in which the positive and negative mains are in independent chambers. The English journals, Jan. 18, speak of a gas leak detector in which the hydrogen flame is used.

Explosion in Conduits.—Mr. Higgins in the Lond. "Elec.," Jan. 18, suggests that hydrogen gas is generated in great quantities in the soil due to the oxidation in iron pipes, which if not protected oxidize very rapidly, and being inodorous the gas cannot be detected by its smell.

Explosion in St. Pancras.—A report of the Board of Trade inquiry is published in the Lond. "Elec. Rev.," Jan. 18.

Underground Mains.—The Lond. "Elec." and "Elec. Eng.," Jan. 18, give an illustrated description of the Spence-Doulton system, which is claimed to be the first attempt to successfully combine the advantages of the drawing-in system with those of bare copper strips; it consists of tubes of vitrified stoneware supported on insulating bridges of the same material, in a trough of earthenware, concrete or iron; the joints of the tubes are bored and turned and require no cement; there is practically no depreciation, as the materials are all imperishable; the first cost is not as low as that of bare strips on insulators, but it is small in comparison with the advantages.

Carrying Capacity of Conductors.—An article on this subject by Mr. Talbot is published in the "Elec. Rev.," Jan. 30, he gives a brief summary of a number of the published rules.

ELECTRO-PHYSICS AND MAGNETISM.

Discharge Through Gases.—A royal institution paper (read April 13) by Prof. J. J. Thomson is reprinted in full with illustrations in the Lond. "Elec. Rev.," Jan. 18; it was mentioned in the Digest, Sept. 15; it is well worth reading by those interested. He believes that the discharge through gases elucidates the connection between mechanical and electrical effects and therefore throws light on the connection between electricity and matter; he describes a phenomenon connected with the passage of electricity from the gas to the electrode and from the electrode to the gas; also some properties of the discharge when its course lies entirely in the gas; in a tube 50 feet long the discharge may be observed through a rotating mirror and the luminosity will be found to follow the direction of the positive current through the tube with an enormous velocity, but it is checked at the negative electrode where it lingers some time before entering it; there is an accumulation of the positive electricity in this neighborhood until the potential fall is 200 to 300 volts; there is difficulty in getting from the gas to the metal but in the gas alone the discharge meets with "a ridiculously small amount of resistance." He describes several phenomena in one of which the discharge prefers to go through a plate of mica rather than through a pellet of mercury; alternating discharge between long electrodes in

a vacuum tube does not pass across the nearest ends but goes from the tip of one electrode to the place where the other passes through the glass, thus preferring to pass through the gas rather than the metal; the difficulty in passing from the gas to the electrode depends largely on the gas as also on the electrode and on their relative positions in the electrochemical series; he explained some experiments illustrating this point and believes that there is a temporary formation of a chemical compound between the gas and the metal. He describes experiments in which the discharge passes entirely through the gas, by means of a tube in a coil which induces the charges; he shows in this way that gases are exceedingly good conductors, which statement he proves by experiment; he finds that the conductivity of the gas estimated per molecule is about 10,000,000 times that of dilute sulphuric acid and is greater than the molecular conductivity of even the best conductive materials; if the pressure is diminished below a certain point the conductivity again diminishes. He describes another experiment in which he shows the effect produced by a magnetic field on the discharge; when the latter flows across the magnetic lines it is retarded but when it flows along the magnetic lines it is aided by the magnetic field.

Modern Theories of Electricity.—The Lond. "Elec.," Jan. 18, contains a paper by Mr. Lodge in which he discusses and criticises the recent article of Prof. Rowland (see Digest, Jan. 12); it is partly in the nature of a criticism and partly an expression of approval. Regarding the statement that electricity no longer exists he states that he would not have expressed himself quite as unreservedly; the expression only means that it is the ether which is now claiming the lion's share of attention, but this is hardly a helpful statement; the explanation of how bodies can be charged, he does not consider very luminous, but that to explain electrification by friction he considers better; the phrase that the lines of force cannot pass through a vacuum should be interpreted that they cannot move through it, as the vacuum has dielectric properties; he considers the statement regarding the earth's magnetism as "full of more than doubtful hypotheses;" he states that it has never been proved that magnetism is certainly due to rotation of something nor that rotating ether is the necessary and sufficient whirling material, all that is known is that rotating electrification is sufficient; a large number of experiments having negative results can be shown in reply to the statement that the spinning of matter on its axis magnetizes it; he approves of the statement that it is air which causes disruptive discharges.

Electrostatic Capacity of a Line Carrying a Current.—An Academy paper by Mr. Vaschy is abstracted in "L'Ind. Elec.," Jan. 10. In a recent note Mr. Potier remarked that the capacity per unit of length is well defined while the electricity is in equilibrium at the surface of the wire, but not so when a current passes; the present writer investigates this subject mathematically when a continuous current passes and finds that the capacity per unit of length of a cable traversed by a continuous ("permanent") current has the same significance as in electrostatics; but when the variations of the current are very rapid one can no longer suppose that the electric field admits of a potential and the idea of a capacity, defined as above, disappears.

Potential in Liquid Moving Conductors.—In an Academy paper by Mr. Villemontée published in "L'Ind. Elec.," Jan. 10, he describes experiments to determine if the circulating of a liquid in large glass tubes having the same cross section throughout can produce a difference of potential between two points of the liquid; his conclusions are that it cannot, at least within the limits between which he experimented.

Retardation of Polarization in Dielectrics.—A paper from the Italian by Mr. Arno is translated in the Lond. "Elec.," Jan. 18. He refers to the experiments of Ewing and Klaassen regarding magnetic hysteresis and points out an analogy with dielectric bodies which suggest certain predictions which he makes; he then describes briefly a series of new experiments the results of which confirm these predictions.

Conductivity of Organic Salts.—The Lond. "Elec. Eng.," Jan. 18, abstracts very briefly a paper by Mr. Bartoli from the "Gazzetta."

Passage of an Oscillator Wave-train Through a Plate of Conducting Dielectric.—A Physical Society paper by Mr. Yule is abstracted briefly in the Lond. "Elec. Eng.," Jan. 18.

Diffraction and Dispersion of Electric Rays.—A paper by Messrs. Garbasso & Aschkinass from the "Weid. Ann.," Vol. 53, page 534, is abstracted in the "Elek. Zeit.," Jan. 3.

Mercury Switch for Electric Use.—A switch is described by Mr. Maycock in the Lond. "Elec. Rev.," Jan. 18, which, however, appears to contain nothing new; the terminals of groups of batteries end in mercury cups by means of which they may be variously combined. The "West. El.," Feb. 2, reprints the article with the illustration.

Physical Papers.—The Lond. "Elec.," Jan. 18, states that the first number of the "Proceedings of the Physical Society" of London contains abstracts of physical papers from foreign sources compiled under the editorship of Mr. Swinburne; this first set is said to contain many very interesting subjects. (As most of the more important physical papers on electrical subjects appear in full or in abstract in the leading foreign electrical journals, abstracts and references of most of them may probably be found in the files of the Digest.)

Influence of Temperature on Magnetization.—A paper by Mr. Wilde is reprinted in the Lond. "Elec. Rev.," Jan. 18. He discusses the subject and states that the general law for the diminution of magnetization with increasing temperatures is now completely established; he describes and illustrates a magnetometer for demonstrating it; it consists of a suspended needle, one end of which is near the magnetic body which can be heated.

Example of Viscous Hysteresis.—Messrs. Gaze and Johnston in the Lond. "Elec.," Jan. 18, give the results of experiments to determine the time effect of the magnetic lag, by the use of Thompson's permeameter; when the values of H were 192, 48 and 24 the time required for maximum pull was 5, 10 and 20 seconds and the increase over the initial pull was 1.2, 1.6 and 0.9 per cent, the second value being at the bend of the permeability curve.

Magnetization of Nickel Wire Under Stress and Torsion.—A paper by Mr. Nagaoka from the "Weid. Ann.," Vol. 53, page 481, is abstracted in the "Elek. Zeit.," Jan. 3; he finds that a reversal of the magnetization takes place under combined stress and torsion; that the torsion alone is the condition, he believes has not yet been proved.

Distribution of Energy in the Spectrum of the Glow Lamp.—The article by Dr. Nichols abstracted in the Digest last week is being reprinted in "El'ty," beginning with the issue of Jan. 30.

Degree of Incandescence of Lamps.—A reprint of Mr. Crova's paper abstracted in the Digest, Nov. 17, is published in the "Elec. Age," Jan. 26.

Curious Magnetic Phenomenon.—In the "Elec Rev.," Jan. 30, Mr. Stone describes the observations of Mr. Burnie, a description of which was given in the Digest, Dec. 29.

Alternating Current.—The 31st "Leaflet" by Messrs. Houston and Kennelly is published in the "Elec. Eng.," Jan. 30; it treats of impedance, reactance, the combination of alternating currents, etc.

ELECTRO-CHEMISTRY AND BATTERIES.

Walker-Wilkins Battery.—The Lond. "Elec. Rev.," Jan. 18, abstracts at some length, including curves, data and an illustration of the battery, from the report made by Prof. Jamieson. The atmosphere is used as the depolarizing agent, the nascent hydrogen meets with the condensed air in the pores of the carbon and combines with it; the hydrogen therefore "never assumes a gaseous form and polarization is prevented;" the life of the electrolyte is said to be remarkable; the battery is composed of an amalgamated cylinder of zinc immersed in a solution of caustic potash contained in a porous cup placed in a large perforated outer vessel, the space between them being packed with carbon, that in contact with the porous cup being powdered; the current is collected by means of a perforated nickel cylinder embedded in the carbon; the claims are freedom from fumes, simplicity of cells and solutions and absence of local action; these claims are corroborated by the report; the results are given in tables and curves which show an efficiency of the zinc of 97 per cent., which he says is better than that of any primary cell that he has tested and he believes the cell to be the best of its kind that he has ever tested. Editorially it is stated that the E. M. F. is low (1.457 on opening circuit) droping 8 per cent. at once, and that it is not nonpolarizing; it will doubtless do for a small output but the slow depolarizing action is not sufficient for heavy work. The complete report is published in the Lond. "Elec. Eng.," in which it is stated that the cost of the electrolyte is 16c. per gallon; also that the electrolyte would yield 768 ampere-hours (but whether this is for one gallon or for 3 quarts is not clear from the way it is stated).

Electrical Energy Direct from Coal.—Mr. Tatlow writes to the Lond. "Elec.," Jan. 18, stating that he tried the same experiment (see Digest, Nov. 10, Dec. 8, 15, 29, Feb. 2) using carbon electrodes, one of which was in cupric chloride and the other in cuprous chloride in hydrochloric acid, using a porous partition; cupric chloride was used because the air oxidizes the cuprous chloride; the E. M. F. was found to be about 0.2 and when coal gas was used it rose to 0.36; a similar result was obtained by churning the cuprous chloride with petroleum oil; by using chromic acid as an oxidizing agent in place of cupric chloride the E. M. F. was 0.79 volts; as the theoretical voltage for the oxidation of either hydrogen or carbon monoxide is nearly 1.5 volts, a large balance remains unaccounted for.

In a communication of Mr. Winand to the "Elek. Zeit.," Jan. 10, he states that he made tests in 1887 and came to the same conclusion as Dr. Borcher that coal cannot be used directly but should first be converted into generator gas. He states that there is very little literature on the subject and mentions a patent of Mr. Bernstein. He fears that the results of Dr. Borcher are of interest only theoretically, and that the problem will be solved in a way not yet discovered.

Copper Zinc Accumulators.—In a paper by Dr. Schmidt abstracted briefly in the "Elek. Zeit.," Jan. 3, he gives a brief description of this cell. Among other things he states that they should be heated to about 86 degrees F. while charging, to prevent dissolving of the copper oxide, care should also be taken that the charging voltage does not exceed one volt; but if some copper has been deposited on the negative electrode it can be removed by reversing the accumulator; he gives the voltage as 0.75; the weight per stored kw-hour is about 132 pounds which he says is about half that of the lead accumulator; the efficiency in watt-hours is about 60 per cent.; he believes there is a great future for this accumulator for traction purposes as it shows an exceedingly small amount of wear and can be discharged without injury at any desired current. Some further information about this type of accumulation is given under "Accumulator Traction."

Secondary Battery Patents.—The Lond. "Elec.," Jan. 18, gives some illustrated abstracts of the five remaining patents which will expire during the year in England.

Testing for Poisonous Minerals.—According to "L'Elec.," Jan. 19, Dr. Kohn at the Hygienic Congress at Liverpool stated that electrolytic analysis can be employed to great advantage in testing for mineral poisons in the body, such as antimony, lead, copper, mercury and cadmium; it will serve to detect a one-tenth of a milligram of these metals; it is much more sensitive than the other processes, all the more so because it can be applied in the presence of organic substances.

Electrometallurgy of Gold.—In "L'Elec.," Jan. 19, Mr. Andreoli gives a brief summary, including data, of the electrolytic methods used chiefly in the Transvaal Republic.

Theory of Electrometallurgy.—The first part of a paper by Prof. Crocker is published in "El. Power," for January, and will be concluded in the next issue; it will also appear in the "Sc. of Mines Quart." He gives the physical and chemical principles upon which electrometallurgy is based and the relation between the various quantities involved. It applies to electrolytic metallurgy, including electrotyping and plating as well as electrolytic reduction and refining of metals; also to electrical smelting and electrical working of metals—welding, forging, etc. The relation between the electrical quantities—current, direct E. M. F., counter E. M. F. and the resistances of generator, leads and cell—is discussed and methods of predetermining each are given. The formula for the counter E. M. F. of an electrolytic cell (covering also the direct E. M. F. of voltaic cell) is deduced and explained, including the equation of Helmholtz. The latter is usually ignored entirely by other writers or is merely stated without explanation. The fact that the E. M. F. of an electrolytic cell may have any value from about +3 to −3 volts is shown, and the common fallacy of supposing that it must be a *counter* E. M. F. between 1 and 2 volts is pointed out. The distinction between the counter E. M. F. and resistance and the use of aqueous and non-aqueous solutions as well as fused electrolytes are considered. Various formulas are deduced for the weight of metal deposit and the relation between this weight and the chemical composition of the electrolyte is explained, the latter being sometimes a puzzling matter to electrical engineers. The leakage of current which occurs when the counter E. M. F. is greater than the direct E. M. F. is accounted for. The important process of "selective electrolysis" or picking out of a particular metal or metals from mixed electrolytes, also the converse process of depositing alloys and the chemical and physical nature of deposits are all treated. The article closes with a discussion of the principles of electrical heating as applied to smelting and working of metals. The article is devoted chiefly to the fundamental principles.

Cold Galvanizing Process.—The importance of the successful application of this electrolytic process is discussed favorably in a recent paper by Mr. Wood abstracted in the "Eng. News," Jan. 31.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Measurement of Self-Potential of Straight Wires.—A paper by Mr. Prerauer from the "Weid. Ann.," Vol. 53, page 772, is abstracted in the "Elek. Zeit.," Jan. 3. He used Maxwell's bridge method for comparing self (induction) potentials and considers that the results show that the method is sufficiently sensitive and exact to measure such potentials up to 500 cm with an accuracy of 1 per cent., in wires whose time constant lies beween 10 to the minus 3d power and 3.10 to the minus 5th power, seconds.

Determining the Form of Waves.—A Physical Society paper by Mr. Janet is abstracted in "L'Ind Elec.," Jan. 10. He refers to his previous paper on the determination of the form of the periodic currents as a function of time and describes a modification consisting of a series of styles equidistant from the others by which one obtains a series of blue lines the extremities of which represent the desired curve; the description is not as clear as might be desired.

Differential Meter.—The Aron type of 1893 is briefly described and illustrated in "L'Eclairage Elec.," Jan. 5.

Instruments and Measurements.—See Crompton's presidential address.

Electrostatic Voltmeter.—Some additional information regarding the Rowland voltmeter (see Digest, Jan. 26) is given in the "Elec. Eng.," Jan. 23. The form which he finds best is vertical with only the quadrants and the equivalent of the needle immersed in the oil in the bottom of the instrument while the pointer is free in the air; the constant of the instrument remains unaltered with time provided the fluid is not changed; with ordinary oil the spaces can be so much smaller than in air that the forces are immensely greater while good insulation is maintained. In one case in which 1,000 volts were used a contact occurred under the liquid but the instrument was not injured in any way although about a yard of wire outside of the instrument was deflagrated with a loud report.

Units of Light and Radiation.—Prof. Macfarlane's Institute paper abstracted in THE ELECTRICAL WORLD, Jan. 26, page 95, is published in full in "El'ty," "Elec. Rev.," Jan. 30, and "Elec. Age," Jan. 26.

Electrical Standards.—The "Elec. Age," Jan. 26, reprints from the English journals Aug. 31 the new standards of electrical measurements for use for trade in England (mentioned in the Digest, Sept. 22).

TELEGRAPHY, TELEPHONY AND SIGNALS.

Telephonic Disturbances.—The "Bull. l'Ass. Ing. El. Montefiore," Dec. 15, contains a paper by Mr. Pierard in which he describes tests made to determine the disturbing effects produced by aerial lines such as those of railway circuits. The disturbances began to be great when the wires were 30 feet apart and the length exceeded 1,500 to 2,000 feet; in the paper, he seeks to determine the causes; his conclusions from a number of experiments are as follows: that the electrostatic effects are those which make themselves felt first even at relatively great distances of 150 to 1,000 feet according to the length of the circuits; that these effects alone can cause serious disturbances; that when one of the earths of the telephone circuit is too near the rails the derived currents may be more or less disturbing; that they are very great when both earths are near the railway earths, the telephone circuit then forms a shunt circuit to the rails; that the electromagnetic effects appear to be negligible in all cases or at least far inferior to the others.

Telephone Loops Without Induction.—In the "Elek. Zeit.," Jan. 3, Mr. Rodewaldt referring to a recent article (abstracted in the Digest, Dec. 29) disagrees with the statements made; he believes the reason for the good results is an entirely different one, namely, that the supports for the insulators of each separate loop are connected metallically; he believes that this is the only reliable method for preventing cross-talk and that in addition, these supports should be insulated from the pole. In an editorial reply it is stated that while the latter is probable it cannot be considered to have been proved.

Telephony.—In a review of the progress of the past year in the "Elek. Zeit.," Jan. 3, are mentioned the improvements in the switchboard of the Western Electric Company (1893 model) the introduction of platinum contacts on the switchboard, also that the practical solution of the automatic switchboard appears to have been solved by the Nissl apparatus.

Telephone Switchboard.—An improvement is described and illustrated by Mr. Engelman in the "Elek. Zeit.," Jan. 10.

Telegraphy.—In a review of the past year in the "Elek. Zeit.," Jan 5, it is stated that a direct cable from Germany to America has been under consideration and there are hopes that it may be realized in the not very distant future. An important improvement in the Hughes apparatus is the replacing of the brake regulator by one of symmetrical construction; another improvement is the introduction of sounders on many lines; the Rathenau researches for telegraphing without a wire are also mentioned (see Digest, Dec. 1.)

Muirhead vs. Commercial Cable Co.—The "Elec. Rev.," Jan. 18, contains a communication by Mr. Bailey in which he criticises a recent statement regarding the delusion of supposing that an accurate balance can be obtained by the rheostat. The subject is also discussed in a short communication in the same issue.

Railway Signals.—An automatic system for ringing alarms at crossings is illustrated and described by Mr. Kohlfuerst in the "Elek. Zeit.," Jan. 3.

Motor for Railway Signals.—A weight motor started and stopped from a distance by means of a current is described at some length and fully illustrated in "L'Elec," Jan. 19.

Telephone.—A correspondent to the "Elec. Rev.," Jan. 23, calls attention to the importance of renewing the contact surface in microphones and gives a short description with sketch of the Mercadier and Anizan microphone described in the Digest last week.

Carbonnelle Microphone.—A brief description of this apparatus which was described in the Digest Jan. 12, is given in the "Elec. Rev.," Jan. 23.

Mexican Central Railway Telegraph System.—The "Elec. Eng.," Jan. 30, contains a short article on this subject by Mr. Guy.

MISCELLANEOUS.

Unconsciousness Produced by an Electric Shock.—"L'Elec.," Jan. 19, reprints from the "Medical News" a description of a case in which a man was rendered insensible by a shock from a 1,000-volt current; at first he was blind, then became delirious; after recovering consciousness he could remember absolutely nothing from the time he received the shock; he subsequently recovered completely. It is claimed that it is an argument in favor of electrocution that unconsciousness is produced the moment the current is applied.

Methods of Resuscitation.—Those recommended by the French Academy mentioned in the Digest, Feb. 2, are reprinted in the Lond. "Elec. Rev.," Jan. 18.

Electricity and Plant-Growing.—The Lond. "Elec. Eng.," Jan. 11, abstracts a paper by Mr. Baily, of Cornell, from the "Transactions of the Mass. Horticultural Soc." The paper does not admit of being abstracted. Among other things he states that the arc light exerts a powerful influence on plants, which, however, varies, due to the effort of the plant to adapt itself to the new conditions; lettuce can be profitably aided, and probably many flowers also. He discusses experiments to determine the effects of electric currents on growing plants, stating that it has not been proved that the effects which have been noticed were due to the mere electrification of the soil, as they may have been due to some chemical or mechanical effect which the current exerted upon the soil or the interstitial air; he is convinced, however, that marked effects may be produced by the application of electricity to the soil; atmospheric electricity probably exerts a powerful influence upon vegetation. He describes some experiments by Prof. Lemstroem, the conclusions from which are that simultaneous action of electricity and high temperature is injurious to plants, although if the weather is not too hot, atmos-

pheric electricity influences plants profoundly and usually beneficially; it is probably due to some chemical change in the atmosphere; Prof. Baily expects to supplement these experiments in this country.

Lightning Effects.—The "L'Elec.," Jan. 19, relates a case in which 23 telegraph poles were struck by lightning probably at the same instant; the effect was different on all of them, some were splintered throughout while some were destroyed only at the top, in others the discharge was distinctly marked by a regular spiral encircling the pole.

Artificial Rubber.—According to "L'Elec.," Jan. 19, a more or less resisting rubber can be made by dissolving 4 parts of nitrocellulose with 7 parts of bromonitrotoluol; by varying the proportion of the former it has elastic properties greatly resembling that of rubber and even of that of gutta percha; according to the "Rev. de Chime. Ind.," the latter constituent can be replaced by nitrocumol and its analogous compounds.

Review of the Past Year.—In a brief review by E. H. in "L'Ind. Elec.," Jan. 10, he states that there has been no important discovery during the year, and that progress was slow but continuous; he considers the Welsbach gas burner a most important competitor to the electric light; he reviews the progress in several directions and states among other things that "in several years, transmissions by belts will be an encumbered and superannuated system, an old process which one will look at as a historical curiosity." He refers to the Heilmann locomotive the first trials of which do not seem to have met the expectations of the parties involved, although two new models are being constructed. In conclusion he says "it has been a good and honest year which will have no electric history."

Progress in Germany.—The "Elek. Zeit.," beginning with the issue Jan. 3, publishes the replies of a large number of firms in Germany to the questions regarding the work of those firms during the past year, including recent improvements, and an expression of opinion on the present and the future of the industry in Germany; they are chiefly of local interest.

The Monocyclic System.

Among the United States patents issued Jan. 29 are no less than nine granted to Mr. C. P. Steinmetz. Of these six relate to systems of alternating current distribution and two to monocyclic motors, of which an account is given below, and one to a new method of winding armatures.

The first patent in date of application on alternating current distribution is of April 2, 1894 (533,244), and describes what is termed a monocyclic system of distribution, whereby lamps or other simple alternating current translating devices, as well as multiphased motors, may be supplied with current from a single source of power and a common system of circuits. By means of this system generators may be installed for an ordinary lighting system, and wherever it is desired to operate motors as well as lamps, it is only necessary to run an additional main to the points where the motors are located and to maintain upon this main an E. M. F. of displaced phase so that between it and the simple alternating motors polyphased E. M. Fs. will exist. This end is attained by means of supplementary or phase modifying sources of E. M. F., arranged so as to act jointly with the main source of E.M.F., but having a different phase relation, so that by the combined action of the main and supplementary sources an E. M. F. of displaced phase is maintained upon the third or intermediate main of the polyphased circuit.

The general method consists in the use of a phase modifying coil on the main generator of the ordinary simple alternating type, this supplementary coil having a displaced position from the main winding in the field of force so as to generate an E. M. F. of different phase from that generated in the main winding. This coil is connected at one end to an intermediate point in the main winding and at the other end to the intermediate main of the polyphased circuit, the outside mains of the circuit being connected to the terminals of the main winding.

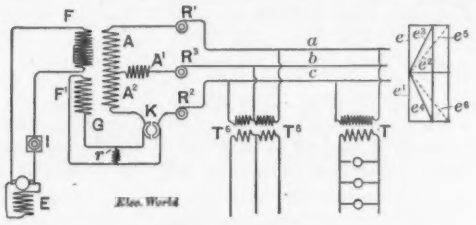
In Fig. 1 such a distributing system is shown diagramatically. The generator comprises an armature winding $A\ A^2$, whose terminals are connected to collector rings $R'\ R^2$ and which is arranged in a manner similar to ordinary simple alternating dynamos. The winding $A\ A^2$ constitutes the main source of E. M. F. and maintains alternating E. M. F. waves in the mains $a\ c$ connected respectively to the collector rings, and which constitute either a simple alternating circuit or the outside mains of a polyphase circuit. The field of the generator is wound with a coil F in circuit with a separate shunt-wound exciting dynamo E, and a resistance I is provided for regulating the exciter. For compounding or over-compounding the main dynamo, its field may also be provided with a series coil F', the current in which is rectified by a commutator K'; a resistance r' is shown shunting the commutator brushes to prevent sparking, though this forms no part of the invention.

The intermediate main b of the multiphase circuit is connected to a third collector ring R^3, and the phase-modifying coil A', which occupies a displaced position in the field of force, has one terminal connected to this collector ring and its other terminal to a point at or near the electrical centre of the main winding as shown in the diagram.

When simple alternating current translating devices alone are used, the phase-modifying coil will be open circuited, and at such times the system will operate in all respects as any ordinary alternating system, the translating devices, such as lamps, being connected electrically or inductively with the outside mains $a\ c$, and the intermediate main being dead. When polyphase currents are desired the phase-modifying coil is connected to the intermediate main, and E. M. Fs. are then maintained between this main and the mains $a\ c$, respectively, due to the resultant action of the coil A' and the halves of the main winding $A\ A^2$, which are out of phase with one another and with that maintained by the unmodified action of the main winding between the mains $a\ c$. When now translating devices are connected with the three mains, polyphase currents are obtainable having a phase relation determined by the resultant action of the main and supplementary sources of electromotive force.

In the diagram, Fig. 1, a circuit of lamps which require only simple alternating currents is shown connected inductively through the transformer T with the mains $a\ c$. At the right of the figure a system of transformers is shown, suitable for transforming multiphase currents derived from the three mains. Two transformers, T^5 and T^6 are used whose primaries are connected in series and whose free terminals are connected to the mains $a\ c$, while the intermediate main b is connected to a point between the primaries. The secondaries are similarly connected. Such an arrangement will transform the primary currents into secondary currents of different potential but having the same phase relation. Another figure in the same specification shows in addition a simple alternating generator connected between the mains $a\ c$.

Fig. 2 shows how the angle of displacement of phase maintained in the main b depends upon the relative phases of the component E. M. Fs. due to the phase-modifying coil and main coil. e represents the E. M. F. of one-half the main winding A, e' representing the E. M. F. due to the other half, A^2, of the winding and e^3 that due to the phase modifying coil. The resultant E. M. Fs. maintained between the main b and the mains $a\ c$ will then be represented by $e^6\ e^4$. If now the relative value of the components is changed, as, for example, by increasing the value of



FIGS. 1 AND 2.

e^6 while maintaining $e\ e'$ the same as indicated in dotted lines, the resultant E. M. Fs. will assume a different angular position, and consequently the difference of phase will be correspondingly changed. To enable the adjustment of the phase relation a simple method will be to wind the phase modifying coil in sections and provide a switch for cutting more or less of them in circuit.

In this specification the phase-modifying source of E. M. F. is described as consisting of a supplementary coil on the generator. It is, however, not necessary that the modifying source of electromotive force be connected with the main source directly, and in a following application this source is located at a distant point of the line.

In another patent (No. 533,378), for which application was filed April 5, 1894, a different method from that above described is given for attaining the same ends, and which does not necessitate any change in the construction of the type of simple alternating current generator commonly installed.

This method consists in generating by any suitable form of alternator simple alternating currents which may be transmitted over a simple alternating circuit to a district where polyphased translating devices are installed. At such a point the displaced phase E. M. F. is generated and maintained upon a separate main, which with the mains of the simple alternating circuit constitute a polyphased circuit from which polyphased currents are derived. By this means it is not necessary to run the additional main all the way from the main generating station, but only over such parts of the system as demand polyphased currents.

The displaced E. M. F. may be derived at the desired point from a phase converter or machine resembling a synchronous or induction motor, having a main winding such as ordinarily used in machines of this type and a phase-modifying coil, in which, when rotated in the magnetic field, the desired displaced E. M. F. is generated. Fig. 3 illustrates diagramatically a distribution system embodying one form of this invention in which G is a simple alternating generator whose armature winding is connected through rings $R'\ R^2$ and a step-up transformer T' to the mains $a\ c$ constituting a simple alternating circuit. O is the field winding of the alternator, supplied by a continuous current from an exciter E, which is regulated by a resistance R; T' and T are step-up and step-down transformers, and beyond T is a sub-circuit $a'\ c'$ on which are shown incandescent lamps $L\ L$.

For the purpose of obtaining polyphase currents for operating polyphase motors installed on this sub-circuit, there is provided a phase converter M^5 which has an armature winding A, A^2, whose terminals are

connected to the mains a' c', and which therefore receives simple alternating currents from such mains. This machine is of the synchronous type, having its field supplied with continuous currents from an exciter E, and regulated by a resistance R in the exciting circuit. The main armature winding A A^2 is the same as that used in simple alternating machines. A phase modifying coil A', connected at one end to the central point of the main winding, leads through a collector ring to an additional or middle main b' which with the single phase circuit mains a' c' constitute for all practical purposes an interconnected polyphase circuit. The coil A' occupies a displaced position relatively to the main coil in the magnetic field.

When so constructed the armature of the machine M^5 will rotate, as in the case of an ordinary synchronous motor, and the modifying coil

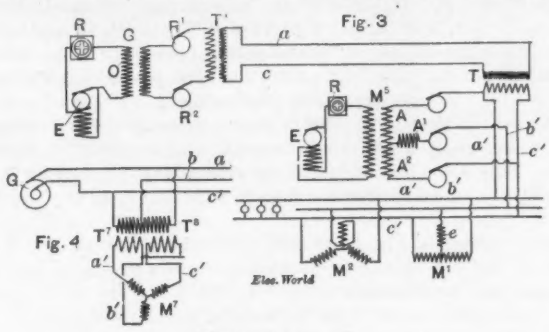


Fig. 3

Fig. 4

FIGS. 3 AND 4.

A' gives rise to and maintains on the middle main b' a displaced E. M. F. such that polyphase currents will be delivered to translating devices whose terminals are joined to the three mains. Such translating devices are shown at M', M^2. M' represents a motor constructed in a manner similar to machine M^5. It has a main winding connected across the mains a' c' and a supplementary winding e coupled between the middle main b' and the central point of the main winding. This last coil occupies a displaced position in the field of force corresponding to the displacement of phase existing between the middle main and the outside mains. M^2 represents a three-phase motor either of the synchronous or induction type, provided with a so-called Y winding and with its different coils connected to the mains a' b' c'. One of its coils, namely, that joined to main b', is reversed, so that it may operate as a three-phase motor with currents flowing in the coils 120 degrees apart in phase, though in the diagram it is assumed that there is only 60 degrees difference of phase between the middle main b' and the outside mains.

A second illustration to the same specification represents transformers interposed between the motors and the line.

Still another modification is shown in which no change in the construction of the machines now in common use is required. Referring to Fig. 4, G is a simple alternator. Two transformers T^7 T^8 have their primaries connected in series with the mains a c, while from the central point between them is run a third main b. M' represents a three-phase motor having a Y^2 winding. The terminals of two of the motor coils are connected by mains a' c', with the secondaries of the transformers, while the third coil is connected to main b'. The secondary of the transformer T^8 is reversed so as to alter the phase relation of the transformed current from 60 degrees on the primary side to 120 degrees on the secondary side. With this arrangement the machine M' will maintain a displaced E. M. F. on the main b', which is reflected back through the transformers and the phase relation of the primary and secondary currents altered in the transformers as well as the potential. In this way it is possible to deal with currents at high voltage by a three-phase machine wound as is customary for comparatively low potential.

Another specification, for which application was filed April 11, 1894 (No. 533,379), describes a system of electrical distribution for polyphased currents whose principal novel feature consists in an arrangement whereby motors of the three-phased type may be operated from line circuits in which currents flow 60 degrees apart in phase, only slight changes being required in the construction of the motors from that of the ordinary well-known induction machines of this class. This change consists in reversing one of the three coils of the motor so that the current flows through this reversed coil in an opposite direction from that in ordinary motors, and therefore produces the same effect, so far as the action of the motor, as that which has heretofore been secured by currents differing in phase by 120 degrees.

Fig. 5 shows diagramatically a system of distribution embodying the invention, in which G is an ordinary alternator except that there is added a phase-modifying coil, as in the other cases described. F are the field coils and E a shunt-wound direct-current exciter controlled by the rheostat R. The phase-modifying coil C' occupies a position in the magnetic field relatively to the main coil of 90 degrees, thus creating an E. M. F. differing 60 degrees from that of the main coils. This phasal relation is secured by properly proportioning the windings of the main and supplementary coils, so that the resultant E. M. Fs. generated by the coil C' and the respective halves of the main winding differ in phase by the desired amount.

For transforming the currents flowing on the mains to a lower potential, two transformers T, T', are used, whose primary windings are connected in series and which are coupled at their free terminals and at the central point c, with the three mains a b c. The secondary windings of the transformers are joined in series and connected in an exactly similar manner to secondary mains a' b' c'. A three-phase motor, M, is provided with the three usual coils e e' e^2, two of which, e and e' have corresponding terminals connected at a common joint t, while the third coil has its opposite terminal connected to the same joint. The winding, it will be observed, is of the usual Y-pattern and differs from the ordinary construction only in the reversal of the coil e^2. The free terminals of the coils are connected respectively to the mains a' b' c'. With this arrangement currents flow between the mains a' c' and b' c', which differ by 60 degrees in phase, but by reversing the direction of the current in the coil e^2, the relation of the currents, so far as the operation of the motor is concerned, is changed so that the motor operates in a similar manner to any ordinary three-phase motor when its terminals are connected to mains carrying currents 120 degrees apart in phase.

Another figure accompanying the same specification illustrates a system similar to the above except that the monocyclic currents are not generated directly at the power station, but supplied by a phase converter (motor-generator) taking current from a simple alternating circuit.

Another patent (No. 533,245) for which the application was filed April 13, 1894, describes a system of electrical distribution for multiphased currents by which currents 60 degrees apart may be converted into currents 120 degrees apart in phase, or the reverse, thus rendering possible the generation and distribution of currents 60 degrees apart in phase and their conversion into currents differing 120 degrees in phase and suitable for operating three-phased motors of the ordinary type or other three-phased apparatus. By this method monocyclic currents may also be converted into three-phased currents.

The conversion of one system into the other is effected by two transformers in which the primary and secondary windings occupy relatively a reversed relation, so that in a 60-degree system the phase of one of the currents will be changed through the angle of 180 degrees, thus occupying a phasal relation with reference to the other two currents such that all the three are 120 degrees apart.

Fig. 6 represents diagramatically the system of distribution in which 60-degree or monocyclic currents are converted into 120-degree or three-phased currents, G being, as in Fig. 5, a monocyclic generator.

For converting their currents into three-phase currents, two transformers, T, T' are employed whose primary coils are joined in series at the point e. Their free terminals are connected to two of the mains a c, and their connected terminals at the point e are joined to the third main b. The secondary windings of the transformers are coupled in a similar manner to mains a' b' c', but one of the secondary coils, as, for example, that of transformer T, is reversed, as shown in the diagram.

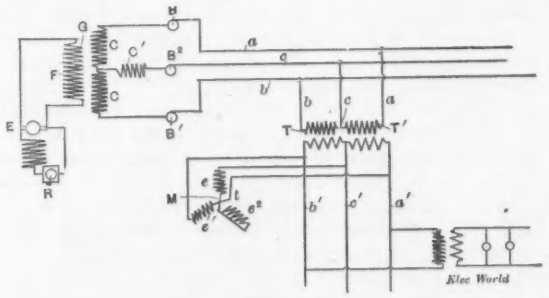
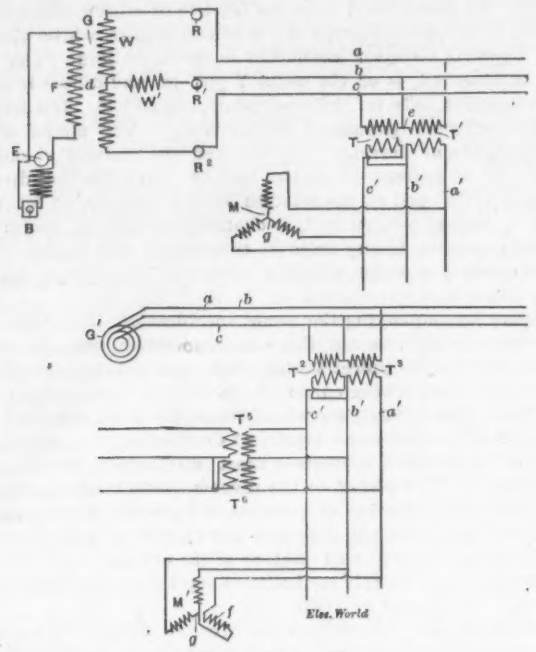


FIG. 5.

This will result in shifting the E. M. F. maintained between the middle main b' and one of the outside mains through an angle of 180 degrees, so that the phasal relation of the E. M. Fs. on the secondary side of the transformers will be 120 degrees apart instead of 60 degrees apart, as they are on the primary side. Instead of reversing one of the secondary coils, the same change of phase may be secured by reversing one of the primary coils. The three-phase currents thus procured may be used with motors, lamps, etc., as desired.

In Fig. 7 the generator G' is of the three-phase type, and the E. M. Fs. maintained between the mains a b c are 120 degrees apart in phase. These currents may be converted into a monocyclic system by two transformers, T^9, T^{10}, connected in series to the mains a b c, in a manner similar to the transformers T, T', shown in Fig. 6, and already described. The secondaries of the transformers are connected to mains a' b', c', but the secondary of transformer T^{10} is reversed, so that the two E. M. Fs. between the main c' and the mains a' b' are 60 degrees apart in phase, instead of 120 degrees, as is the case on the primary side. The secondary currents may be utilized for operating translating devices in any desired manner.

Motors may be run from all three mains by using a system of transformers, T^5, T^6, in all respects similar to T, T' as described in connection with Fig. 6, or, by modifying somewhat the construction of the ordinary three-phase motor, they may be connected directly with the mains a', b', c'. This modification consists in reversing one of the coils of the motor, as shown at M'. Here the motor has three windings, having one set of terminals connected to a common joint g, and their free terminals to the mains, but instead of the arrangement shown at M, one of the coils, f, is reversed. This illustrates how motors of this type may be



FIGS. 6 AND 7.

operated from the mains a', b', c' without reconverting the 60-degree currents into true three-phase currents.

In another patent (No. 533,247), the application for which was filed Sept. 24, 1894, is described a system in which two or more multiphased motors having some of their coils connected across a simple alternating circuit and other coils occupying a displaced position in the magnetic field relatively to the first named, are connected by balance wire; the operation, then, of any one of the motors will produce on this balance wire an E. M. F. of displaced phase which will enable any one of the other motors to be started. Of the two figures which accompany this specification one relates to three-phased motors (Fig. 8), and the other to two-phased motors. G is a simple alternator, E its exciter, and F G a transformer. In one of the branch circuits, a', b', are indicated three multiphased motors, M, M', M^2, with Y-connected coils. Each of these motors has two of its coils connected in series across the simple alternating mains, and the third coil connected to the corresponding coil of the other motors by a balance wire d.

If we suppose that all but one of the motors are disconnected from the supply lines a', b' and the motor M, which is connected, to have been started and to be running, then there will be generated in the coil A', which is connected to the balance wire, an alternating E. M. F. out of phase with the E. M. Fs. on the simple alternating lines a' b'. This displaced E. M. F. is communicated to the balance wire, and if any other motor is then thrown into connection with the simple alternating lines a' b' and the balance wire d it will receive in its coil A' a displaced E. M. F., which, co-operating with the simple alternating E. M. F. on the lines a' b' will serve to start the motor in operation.

It will thus be seen that the operation of any one of the motors will generate on wire d a displaced E. M. F. which enables any one of the other motors to be self-starting. When all of the other motors are in operation the balance wire d may be, and preferably is, practically idle, but in case of abnormally heavy or light load on part of the motors it will serve to transfer energy from the lightly loaded parts of the system to the overloaded parts. In case a motor is put in connection with the supply lines and no other motor has previously been so connected it may be started into operation in any convenient manner. There is shown for this purpose a small switch s, shunting one of the inducing coils of the motor, which, with the proper proportioning of the various parts will cause the motor to start, even when under load.

In another portion of the figure are shown three branch circuits a^2 b^2, a^3 b^3, a^4 b^4, which supply motors M^3, M^4, M^5, through sets of transformers T^2 T'^2, T^3 T'^3, T^4 T'^4, which reduce the potential on the motors. The balance wire d is connected to a point between the primary coils of each set of transformers T^2 T, $T^3T'^3$, T^4 T'^4. The motor M^5 is shown as an induction motor with -connection, and has two of its coils connected in series with the sec daries of the transformers $T^2T'^2$, its third coil being connected between the secondaries of transformers T^3 T'^3. A synchronous motor M^4 is shown having armature coils relatively displaced and connected in Y-connection. These coils are connected to collector rings r^1, r^2, r^3, on which bear brushes c', c^3, connected to outer terminals of the secondaries of transformers T^3 T'^3, and brush c^2 connected to the junction of said secondaries.

A field coil f in circuit with a separate exciter E' is provided for this synchronous motor. M^3 represents a three-phase induction motor having a delta winding, one of its coils being connected in series with the secondaries of the transformers T^4 T'^4 and the junction of the other two coils being connected to the junction of the secondaries of transformers T^4 T'^4. The operation of these devices is the same as that above described except that transfer of the displaced E. M. F. and of energy on the balance wire d is effected with an intermediate transformation by transformers T^2 T'^2, T^3 T'^3, T^4 T'^4. This arrangement is applicable to cases wherein the motors are all in reasonable proximity to the mains a, b, but distant from one another, while the arrangement shown for the motors M, M^1, M^2 is more especially applicable to the case of motors in proximity to one another. At a^5, b^5 is shown a branch circuit containing devices such as lamps L, supplied through a transformer T, from the mains a, b. It is also clear that simple alternating translating devices whether inductive or non-inductive may be supplied from any one of the branch lines a' b', a^2 b^2, etc.

The motors shown in Fig. 8 are all three-phase motors, and it must be understood that ordinary three-phase motors may be employed as here shown without any modification whatever. Such motors in general as heretofore constructed have their three coils similarly wound, so as to be equal in effect—so that the E. M. Fs. generated on the balance wire d would naturally be balanced in the normal operation of the motors; but this equality of action is not necessary. The coils may have unequal relative values in the different motors—so that this balance does not exist, though the balanced system is preferred. For this purpose, however, it is not necessary that the relation between the coils of each motor should be one of equality. It is only necessary that this relation should be the same in the several motors—that is, if one of the coils is stronger in effect than the other coils in one of the motors, the corresponding coil in the other motors should be stronger than the other coils in the said motors. It will also be clear that any other phase relation may be used, and the same system may carry three-phase apparatus in one part and quarter-phase in another part, the balance wires being separate, that is, the three-phase apparatus having one balance wire, and the quarter-phase apparatus another balance wire, or such apparatus of different phase relation may even be connected to the same balance wire by the interposition of appropriate phase-changing apparatus, such as transformers. Such an arrangement is shown in another diagram in the specification.

The final patent in this series (No. 533,248), application for which was filed September 24, 1894, comprises a set of mains connected to and supplied by a source of simple alternating currents, and associated with this set of mains and one or more balance wires on which is maintained an E. M. F. out of phase with the E. M. Fs. on the simple alternating mains. At various parts of the system this third wire is connected with the translating devices which require a displaced E. M. F. for their

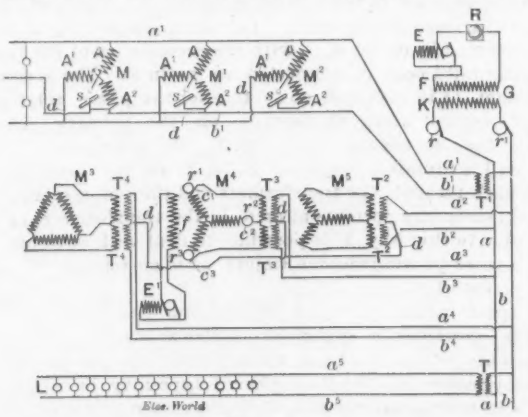


FIG. 8.

operation, as, for example, certain forms of alternating current motors. These motors have some of their coils connected across the simple alternating mains, and from these mains in the normal operation of the motors is derived the energy which actuates them. Other coils of the motors are connected to a balance wire and are supplied thereby with a displaced E. M. F.

In the normal operation of the system, that is, when the load throughout the system is normal, including the load on the motors, then the motors will derive substantially all their operating energy from the simple alternating mains, and the balance wire, while maintaining a displaced E. M. F. on the coil to which it is connected, does not supply any substantial part of the energy which is converted into work by the rotation of the motor. Under these circumstances the system becomes

substantially a simple alternating system and is capable of being regulated and of operating simple alternating devices with the same facility as the ordinary alternating current system. This is termed in the patent the monocyclic system.

Comparing this system with an ordinary multiphase system it is to be noted that in the multiphase system there are three or more mains carrying two or more alternating currents of different phase, each of which supplies a substantial part of the energy required for the normal operation of the multiphase translating devices, and in general the energy

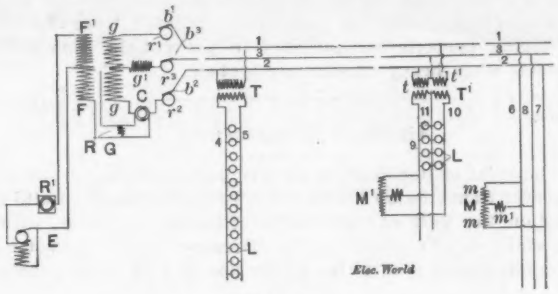


FIG. 9.

transmitted is about equally divided between the several currents. In the case of the monocyclic system, however, as herein described, only two of the mains and the simple alternating current carried thereby are instrumental in the distribution or transmission of energy in the normal operation of the system. The other main or mains in such normal operation supply simply a displaced E. M. F., but do not have any substantial part in the actual transfer of energy. This result is accomplished by adjusting the relation between the impressed E. M. Fs., counter E. M. Fs. and resistances, both inductive and non-inductive, of the several circuits.

In an ordinary multiphase system this relation is such that in the normal operation of the multiphase translating devices the counter E.M.F. developed in each branch or circuit in such devices is considerably less than the impressed E. M. F. existing in such branch or circuit. The consequence of this is that in each of such circuits a current will flow, consuming energy, and this energy is drawn from all the mains. In the monocyclic system, however, as herein described, the impressed E. M. F. in one or more of the branches or circuits of the translating devices is made substantially equal to the counter E. M. F. which is generated in such branch or circuit in the normal operation of the devices, consequently practically no current will flow in such branches or circuits, the E. M. Fs. therein being practically balanced. Under variations of load above or below the normal, this balance will no longer exist and the balance wire will then be traversed by a current. Thus in the case of an over-load on the device in question, the counter E. M. F. will fall below the impressed E. M. F. in the branch connected to the balance wire so that a current will result in the direction of the impressed E. M. F., that is, the device will absorb energy from the balance wire.

On the other hand, in the case of an abnormally light load on the translating device the counter E. M. F. in such device will rise above the impressed electromotive force and current will flow in the direction of the E. M. F., thus supplying energy to the balance wire. The balance wire thus acts as a possible means for transferring and equalizing the load throughout the system.

The displaced E. M. F. on the balance wire may be derived from the same machine that supplies the alternating current to the simple alternating mains, or it may be derived from a separate machine. It is, in fact, immaterial what means are employed to maintain the displaced E. M. F.—whether it is by the action of a source associated with the main source of simple alternating current—or of a source entirely distinct therefrom, or by the action of one or more of the translating devices themselves. Thus certain classes of translating devices, such as motors having displaced coils, are capable of supplying the displaced E. M. F. by their normal operation while deriving their operating energy from the simple alternating mains.

The invention lies not so much in the type or arrangement of apparatus employed as in the proportioning of the forces acting therein, and of the resistances opposed to such forces, so as to bring about a normal condition of static equilibrium or balance, as regards the balance wire and the parts immediately connected therewith.

Fig. 9 represents diagramatically a system of distribution to which this method is applicable and which includes many of the details described and illustrated above. Other illustrations accompanying the specification show a system similar to the above but in which the displaced E. M. F. is derived directly from the main source of simple alternating current, a system in which the displaced E. M. F. is obtained by the action of the translating devices themselves; a system in which the displaced E. M. F. is supplied by a motor generator and one employing a three-phase generator.

Referring to Fig. 9, *G* is an alternating current generator having a main armature coil *g* and as in the preceding illustrations, an additional coil, *g'*, angularly displaced (preferably 90 degrees) with reference to the main coil, and connected at one end to the intermediate portion of the main coil and at its other end to a third collector ring. The generator shown is compound wound, having one field coil *F* included directly in the simple alternating circuit through a rectifying commutator *C*, a resistance, *R*, shunting the break of the commutator to prevent sparking; the other field coil *F'* has a separate exciter *E*.

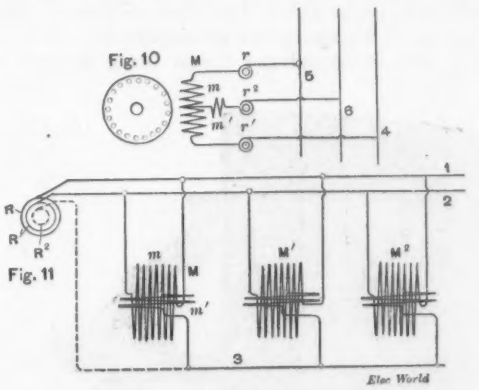
The circuit 4-5 indicates a simple alternating transformer and branch circuit, the energy for which is derived altogether from the main generating coil *g* of the generator; 6-7 is a connection to an induction motor *M* having an inducing winding with main and supplementary coils similarly arranged to those of the generator *G*, the simple alternating lines 6 and 7 leading to the main coil *m* of the motor and the balance wire 8 leading to the supplementary coil *m'*. These coils may be supposed to act upon a closed coil armature in the usual manner, and when the motor is started from rest the displaced E. M. Fs. supplied to its angularly displaced coils will furnish the torque required for starting. When the motor is running a counter E. M. F. is developed in all of its coils, and the counter E. M. F. between the lines 6 and 8 and between the lines 7 and 8 will be the resultant of the counter E. M. Fs. generated in the supplementary coils *m m'*.

The direction and magnitude of the current flowing in the several branches of the circuits of the motor depends upon the relation between the impressed and the counter E. M. Fs. in the respective branches or circuits. By properly proportioning the windings of the generator or of the motor by properly adjusting the impedance of the several circuits, the effective impressed and counter E. M. Fs. in any one of the branches can be made substantially equal when the motor is running at normal speed and load. The motor *M* is shown directly connected to the main and the third wire, but transformers may be included in the connections if desired, as shown in the circuit 9-10-11.

Patents Nos. 533,249 and 533,250, of which the applications were filed November 20 and 24, 1894, respectively, relate to a monocyclic motor.

The motor is represented diagramatically in Fig. 10. Its primary member is provided with mains and "teaser" windings *m* and *m'*, the collector ring r^2 being connected with a line making connection, say, at the generator with a coil displaced in phase from that of the simple alternating current flowing in the two outside lines represented.

Fig. 11 represents three monocyclic motors connected to a simple alternating circuit and with their teaser coils connected to a balance wire 3. When the motors are in normal operation the balance wire will carry substantially no current. Currents, however, may be conveyed over this wire from one motor to another when one is loaded unequally, or when one or more of the motors are starting or running at other than the normal speed. In starting a motor of this character the field of the machine



FIGS. 10 AND 11.

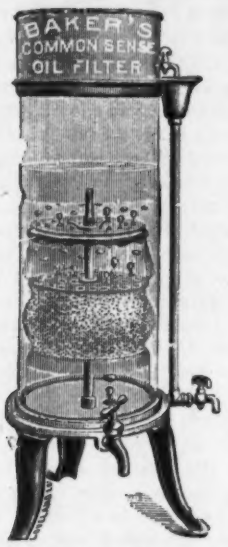
should be left unexcited until the armature has been brought to speed, as is now the common practice with different forms of polyphased motors.

Common Sense Oil Filter.

The oil filter we illustrate, made by F. H. Alling, New Haven, Conn., has the unique advantage of the entire operation of filtering being plainly visible.

The filtering medium is all submerged in water, and occupies the upper portion of two bell-shaped glasses. The oil to be filtered is put into the tank on top of the filter, and is fed down through the side pipe, entering the filter at the bottom near the centre. Oil, being lighter than water, immediately rises through the water and accumulates beneath the filtering material, being enclosed by the bell. By capillary attraction and its gentle pressure upward from its lighter gravity, it gradually goes up through the filtering material in the lower glass bell, and is caught and required to pass through the upper one in the same manner, the clean oil accumulating on top of the water, and is drawn off at the front faucet, which communicates with the central pipe. The side faucet is to draw off the water.

Through the difference of specific gravity of water and oil, the latter rises, while the iron and babbitt and most other impurities found in the oil, being heavier than water, have a tendency to fall; this tendency, however, is greatly diminished by the water, whose specific gravity subtracts



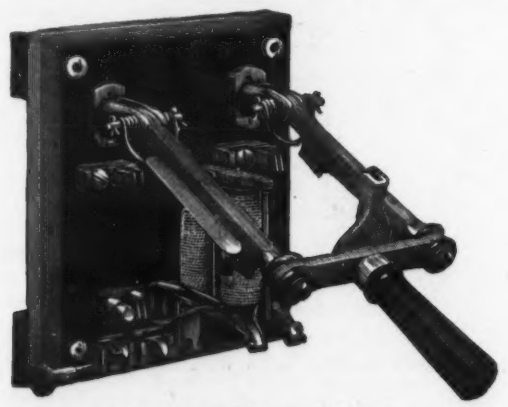
Common Sense Oil Filter.

from that of these substances, and thus they have a very moderate inclination to drop. As a result of these two modifications there is a very gentle, but sure, tendency to separate, and this condition permits oil being filtered successfully for any length of time. The filtering material used is such as has been proven by most thorough experiment and constant use to be the best, not only for some kinds of oil, but for all kinds. The filter is made of glass, so that the operation is visible.

Automatic Motor Switch.

In order to prevent the burning out of armatures and other accidents which not infrequently occur to electric motors through accidents or carelessness of the attendants, the Brodie Electric Company, of Manchester, N. H., has brought out an automatic motor switch shown in the accompanying illustration.

The switch is designed to open the circuit, not only when an abnormal current passes through the armature and thus to prevent danger from overloading, but also to disconnect the motor whenever the field current ceases from any cause, as through the circuit being thrown off at the



Automatic Motor Switch.

central station or any other reason. It thus prevents damage which is likely to result if the current should suddenly be thrown on again.

To accomplish the above named objects an ordinary double-pole jack-knife switch of approved design is employed which is supplied with special springs tending to hold it in an open position. Between the blades of the switch is mounted an electromagnetic controlling device consisting of a differential electromagnet controlling the position of a detent, which detent is capable of engaging with the switch and holding it closed, but if the current increases above a certain amount the detent releases and the switch is thrown open. One of the spools on the electromagnet is in series with the motor armature, while the other is traversed by the field current of the machine.

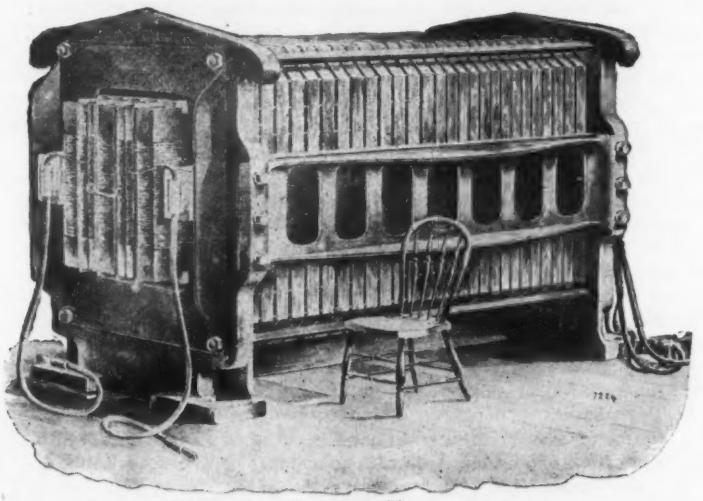
The operation of the device is as follows: Upon closing the switch the detent through the influence of the field current holds the switch in a closed position and the motor may be started by the rheostat in the usual way; if, however, at any time through overloading the armature current exceeds the proper amount, the magnetism due to it preponderates over that due to the field current and the detent releases, allowing the switch to open and disconnect the motor; or, if the current supplied to the motor fails from any cause, the magnet immediately loses its power, the switch is instantly released, and the motor is protected from the damage that might otherwise occur from the sudden resumption of the current before the rheostat had been thrown back. In order to shut down the motor it is only necessary to press the button on the left hand side of the switch. Wires may be led from the short circuiting contacts to any part of the building where the motor is used, and the buttons may be arranged to shut down the motor from distant points in case of accident. Auxiliary arcing contacts are provided to prevent the fusing of the switch contacts when heavy currents are broken.

Air-Blast Transformer.

The development of transformers of very large capacity for sub-station and large power transmission has been the subject of much careful study and research on the part of the General Electric Company, with the result, it is claimed, of overcoming the difficulties which for some time were considered almost prohibitive of the use of very large transformer units.

The principal difficulty met with in transformer work is the matter of temperature. All large transformers to be efficient and economical must be provided with artificial means of cooling. Many methods have been from time to time proposed for the artificial cooling of large transformers; such, for example, as the circulation of oil through the transformer and a cooling tank or the passage of water or other cooling fluid through pipes within the transformer, all of which have shown themselves to be complicated and inconvenient. The General Electric Company has, however, devised a simple and efficient air-blast system, which consists of a transformer having numerous air ducts through which cool air is constantly forced by means of a blower, the temperature being sufficiently reduced by radiation from the walls of the ducts. This system is practically the same as that by which all large dynamos are kept cool, differing only in that we are so fortunate as to have in the dynamo a rotating armature to create the necessary draft, while in the transformer a separate fan has to be used.

By means of the air-blast the rise in temperature may be readily kept below 60 per cent., or even lower if required, the 200 kw transformers recently manufactured for the Cataract Construction Company having a maximum rise of but 35 per cent. The power required to supply the necessary air-blast, of course, varies with the transformer capacity installed, and also with the distance that it is necessary to convey the air from the blower to the transformer. Under ordinary conditions, however, it will not exceed one-half of 1 per cent. of the total capacity of the transformers cooled, and in large sub-stations it may generally be reduced to one-fourth of 1 per cent.



200-kw Sub-Station Transformer.

A simple method of installing one or more large sub-station transformers is to place them over a duct beneath the floor having suitable openings beneath each transformer for the air-blast, which is maintained in the duct by means of a blower driven from any convenient source of power, the duct at the same time serving as a convenient place to locate all wires coming to the transformers. The air passes through the duct upward through the transformer and may either escape into the surrounding room or may be led away through other ducts as may be found most convenient.

Transformers of the air-blast type are built in the following standard sizes: 40, 65, 75, 100, and 150 kw. Special transformers of intermediate or larger sizes can, however, be furnished almost as promptly as standard apparatus.

NEWS OF THE WEEK

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, Feb. 2, 1895.

GENERAL ELECTRIC has not seen fit to participate in the bettered feeling of most electrical stocks this week. The selling of this stock has at all times during the week been more conspicuous than the buying, and the stock has been weak when the rest of the active list has manifested a distinct tendency to advance. On one day it broke four points on sales of 26,670 shares. There is no doubt that a good deal of long stock has come out, but most of the decline was brought as the result of a well-directed bear campaign engineered by all the old leaders on the down tack. This bear campaign has been long in contemplation, and people on the inside have had definite and precise information in regard to the time and extent of fall in General Electric's quotations. The opportunity came this week and quick advantage was taken of some small sales of long stock following upon the repeated bear stories of last week as retailed in these columns. Liquidation was hurried along by well-circulated reports that the annual report soon to be made public would show large gross earnings but very small net profits. The liquidation was aggravated by the persistent hammering, and quotations finding no support, fairly tumbled over each other. It seems as if insiders have not been averse to the decline, for no effort at all was made to check the slump, no contradictions being made of the current unfavorable rumors, nor any buying for their account. In the last two days quotations have bettered a little, more out of sympathy, however, with the advancing market than through a genuine appreciation of value, and the stock closes for the week in a comparatively bad way, speculatively speaking.

WESTINGHOUSE ELECTRIC issues are practically unchanged, though a slight stiffening in the price of the common is noticed. Reports of current business continue good, and the work of removal to the new Brinton shops is progressing at a rate entirely satisfactory to the company's officials.

POSTAL TELEGRAPH has been strong of late. Its business has recently been increasing by leaps and bounds, the efficiency and despatch of the service having been demonstrated of late on several noteworthy occasions to a degree to invite the most favorable criticism. President Chandler's policy of doing a thing well is apparently receiving its due rewards. Very promising things are told of the company's increasing earnings.

AMERICAN BELL TELEPHONE is still sick. It has been depressed this week more than anything else by reports of ever-increasing competition, which is said to be making great inroads on the company's revenues, especially in Indiana, Ohio and the other middle Western States. The officials have determined to push along the contemplated long-distance extensions, and these new lines will eventually prove a source of profitable revenue that will assure big Bell Telephone dividends for years to come. Nothing has as yet been decided, however, about the auction sale of stock left over from subscription or regarding the issue of the remaining $25,000,000 capital stock authorized last year.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked
Chicago Edison Company	100	128	130
Edison Electric Ill., New York	100	98	100
" " " Brooklyn	100	108	110
" " " Boston	100	123	126
" " " Philadelphia	100	120	125
Edison Ore Milling	100	13	15
Electric Storage Co., Philadelphia	100	35	40
General Electric	100	30	30⅛
General Electric, pref	100	65	70
Westinghouse Consolidated, com.	50	32	32¼
" " pref	50	49⅛	50

BONDS.

Edison Electric Ill., New York	1,000	108	109
Edison Electric Light of Europe	190	75	85
General Electric Co. deb. 5's	1,000	90	90⅛

TELEGRAPH AND TELEPHONE.

American Bell Telephone	100	190	192
American District Telegraph	100	45	49
American Telegraph & Cable	100	92	93
Central & South American Telegraph	100	117	120
Commercial Cables	100	140	145
Erie Telephone	100	47	48
Gold & Stock Telegraph	100	106	110
Mexican Telegraph	100	180	190
Mexican Telephone	100	75	80
New England Telephone	100	67	69
New York & New Jersey Telephone	100	97⅛	99
Postal Telegraph-Cable	100	53	58
Western Union Telegraph	100	88	88⅛

THE ERIE TELEGRAPH AND TELEPHONE COMPANY, Lowell, Mass., has declared a dividend of 1 per cent. for the quarter ended Dec. 31, 1894, and reports a surplus of $159,523.57.

THE UNITED STATES ELECTRIC SECURITIES COMPANY has declared a semi-annual dividend of $3.50 per share on the preferred stock; checks are being delivered to stockholders to-day.

THE NEW YORK AND NEW JERSEY TELEPHONE COMPANY will, on and after March 2, redeem its first mortgage 6 per cent. bonds. In order to pay off its maturing firsts it offers for sale $375,000 5 per cent. 30-year gold bonds at 103 and interest.

ELECTRIC TRACTION stocks have again been lively. Long Island traction remains weak. Added to the depressing effect created by the strike's occurrences comes the report that it is very doubtful whether the company can meet its coming interest and rental obligations and a forfeiture of important leases is thereby threatened. Brooklyn traction, too, continues to sag, and the muddle of litigation following on the strike is not calculated to cheer depressed stockholders. In Philadelphia there have been savage attacks on the Tractions, but there has been a rally, the most violent fluctuations being in Metropolitan, People's and Philadelphia. Consolidated Traction of New Jersey is also down, but Director B. M. Chanley says "there is nothing in the company's affairs to cause a moment's alarm; earnings now exceed fixed charges, and beginning with spring they will equal $2,500 a day above all charges." This means something earned for stockholders.

BOSTON TRADING has been confined to West End. Nothing has come as yet of the threatened labor troubles, the company having, it is reported, made concessions, but the stock naturally is not inclined to rise on such reports.

DUQUESNE TRACTION—A Pittsburgh stock much thought of in the East—has redeemed the promise told of last week by declaring a dividend of 2 per cent. ($1 per share); checks will be mailed on Monday. At present market prices, 28 and 29, Duquesne Traction, with dividends on a 4 per cent. basis, nets the investor 7.15 per cent., which is the largest sum yielded on any Pittsburgh traction stock. Citizens' Traction yields at current prices, 5.10 per cent, Pittsburgh, Allegheny and Manchester 6.4 per cent; Pleasant Valley, 5 per cent.; West End Traction 4 per cent., and Pittsburgh Traction 5 per cent.

BUFFALO STREET RAILWAY—another "foreign" road dealt in here—makes a fine report for the year ending Dec. 31, 1894. Net earnings were $679,652, an increase of $105,943 over the figures for 1893, and there is a surplus applicable to dividends of $210,735, which is nearly 4 per cent on the stock.

ELECTRIC TRACTION STOCKS.

	Bid.	Asked
Union Ry. Co. (Huckleberry)	115	125
Brooklyn Traction, com	11	13
" " pref	58	62
Long Island Traction	10¾	10¾
Rochester St. Ry	36	38
Columbus St. Ry	45	50
Louisville St. Ry. com	37	39
" " " pref	87	88
Cleveland Electric Ry.	59	60
Cleveland City Ry.	68	70
North Shore Traction	23	25
New Orleans Traction	14½	16⅛
New Orleans Traction pref	56½	59⅛
Worcester Traction com.	12¾	14
" " pref.	79	81
Metropolitan Traction, Philadelphia	94¼	96¾
Philadelphia Traction	87	89
People's Traction	49⅛	49¾
Binghamton R. R. common	100	—

BONDS.

	Bid.	Asked
*Union Ry. 1st. mtge 6s	105	108
*Westchester Electric 1st. mtge. 5s	98	101
Rochester St. Ry. 1st. 5s	95	97
*Columbus St. Ry. 1st 5s	95	97
Columbus Crosstown 1st. 5s	95	97
*Binghamton Railroad Co. 5s	99	100

*With accrued interest.

Special Correspondence.

PITTSBURGH NOTES.

PITTSBURGH, Feb. 2, 1895.

PREPARATIONS ARE BEING MADE by local electric light men for a large attendance at the Cleveland convention. Owing to the short ride between here and Cleveland the Pittsburgh delegation will be exceptionally large.

THE PROCESS OF MOVING the Westinghouse electric works from Garrison Alley, this city, to Brinton, is rapidly progressing. The company is expected to extend a general invitation to the guests at the Cleveland convention for a visit to Pittsburgh to the new works. If this should be done those who will take advantage of that invitation will have an opportunity of seeing many interest-

ing sights. The arrangements and equipment of machinery in the new shops are said to surpass anything in the world in a similar establishment, and the Westinghouse Company has facilities there for turning out apparatus that have never been equalled.

A NUMBER OF PROMINENT CITIZENS have inaugurated a move against the local street car companies, which, if it should be successful, will bring lots of new business to car manfacturers. A bill was introduced into the Pennsylvania legislature yesterday compelling street car companies to charge a reduced fare to their patrons when the latter are obliged to ride in the cars and cannot get a seat, in other words, have to stand up. It is said the bill has powerful backing and is being vigorously pushed. The street railway business is now conducted in this city as near perfection as possible. During all the varieties of recent weathers, heavy snow storms, sleet, rain, frost, etc., etc., the operation of all the roads was never impaired, and the street car traveling public were never inconvenienced by undue waiting because cars were not running.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
936 Monadnock Building, Chicago,
February 2, 1895.

THE NASHOLD CLEAT is now being manufactured to the number of 100,000 a month, and still unfilled orders on hand Feb. 2 amounted to 120,000 cleats.

MR. J. P. B. FISKE has severed his connection with the Morgan Engineering Company, Alliance, O. Mr. Fiske was formerly in the motor department of the General Electric Company.

FRED. W. RICHART, Carbondale, Ill., has just completed the installation of a 500-light A. C. incandescent lighting plant, for Wright Bros., Vienna, Ill., using Bain electrical apparatus and Watertown steam machinery.

THE McEWEN MANUFACTURING COMPANY, through Agent Sharp, has captured the order placed by the great retail house that is to occupy the block between Jackson and Van Buren streets on State street. The McEwen Company will supply both engines and direct-connected generators of their own make.

THE CARD ELECTRIC COMPANY, Mansfield, O., reports the following sales of electrical machinery. Citizens' Street Railway Company, Mansfield, O., two single 35-hp equipments and one double 35-hp equipment; Elkhart and Goshen, Ind., five single 35-hp equipments, two double 25-hp equipments, and two double 35-hp equipments; Bloomington, Ill., Street Railway Company, one double 25-hp equipment; Lincoln, Ill., Street Railway Company, one double 25-hp equipment; J. E. Tomlinson, Centerville, S. D., one 35-kw multipolar dynamo; E. C. Hargrave & Company, Hinckley, N. Y., one 30-kw multipolar dynamo; Mansfield Machine Works, Mansfield, O., one 30-kw generator with multipolar motor equipment; The Aultman & Taylor Machinery Company, Mansfield, O., one 30-kw multipolar dynamo; Fulton Truck and Foundry Company, Mansfield, O., one 30-kw dynamo; J. Holt Gates, St. Louis, one 30-kw multipolar dynamo; J. Holt Gates, Chicago, one 30-kw multipolar dynamo; United States Baking Company, Louisville and Indianapolis, two 25-kw multipolar dynamos; Geo. P. Nicolls, Chicago, one 15-hp multipolar generator; Niagara Engineering Company, Buffalo, N. Y., one 12-kw machine, besides numerous other multipolar motors and dynamos of small sizes. For the Niles Tool Works, Hamilton, O., a large special iron-clad reversible motor for working boiler-plate rolls. This motor will be controlled by special reversible controller with long lever handle. The Card Company is making a specialty of this class of work. The factory is now well equipped for work and orders are coming in fast.

General News.

NEW INCORPORATIONS.

THE ST. LOUIS AND JEFFERSON BARRACKS RAILWAY COMPANY, St. Louis, Mo., capital stock $50,000, has been incorporated.

THE CHICAGO BELT LINE STREET RAILROAD COMPANY, Chicago, Ill., capital stock $500,000, has been incorporated by F. J. Phillips, G. P. Loehr, and Andrew Matson.

THE CHARDON TELEPHONE COMPANY, Chardon, O., capital stock $2,000, has been incorporated by Orange Pomeroy and others to build and operate an exchange.

THE MUTUAL AUTOMATIC TELEPHONE COMPANY, Chicago, Ill., capital stock $1,000,000, has been incorporated by Athel E. Mackin, Joseph Kelley and James F. Duhig.

THE FISHERVILLE, BARTERBROOK AND STUART'S DRAFT TELEPHONE COMPANY, Fisherville, Va., has been incorporated by J. W. Paul, P. T. Burkholder, W. F. Gilkeson and others.

THE PEOPLE'S TRACTION COMPANY, New York, capital stock $1,500,000 has been incorporated to operate a street surface road 20½ miles long. F. A. Wilcox, E. H. Hibbs and J. A. Bensel, New York, are the promoters.

THE FULTON ELECTRIC LIGHT AND POWER COMPANY, Fulton, Ill., capital stock $20,000, has been formed to operate an electric light and power plant. C. C. McMahon, Ed. Wyatt and H. S. Remer are the promoters.

THE YORK LIGHT AND POWER COMPANY, York, Neb., capital stock $12,000, has been incorporated to furnish light and power by gas or electricity. H. C. Page, Geo. W. Shuck, S. H. Sedgwick and Geo. R. Reed are the promoters.

THE WESTCHESTER COUNTY CENTRAL ELECTRIC COMPANY, White Plains, N. Y., capital stock $75,000, has been formed to build and operate a street surface road. F. H. Reed, C. A. Johnson, and C. M. Nichols, New York, are interested.

THE MASSACHUSETTS CAR COMPANY, Saco, Me., capital stock $500,000, has been incorporated with G. A. Hilton, Milton, Mass., and W. G. Wheildon, Stoneham, Mass., as treasurer, for the purpose of manufacturing and dealing in cars and railway supplies.

THE RUSHVILLE ELECTRIC LIGHT COMPANY, Rushville, Ill., capital stock $12,500, has been incorporated to supply electric light and power. C. W. Waimnan, John Foote, Chas B. Griffith, J. P. Clarke, Chas. H. Wells and John D. Little are the promoters.

THE METROPOLITAN REGISTER COMPANY, New York, capital stock $10,000, has been formed to make and sell electrical registers and indicators. J. H. Carson, New York; J. B. Benton, Elizabeth, N. J., and J. M. Stoughton, Yonkers, N. Y., are the organizers.

THE GRAND ISLAND LIGHT AND POWER COMPANY, Grand Island, Neb., capital stock $50,000, has been formed to erect, operate and maintain an electric light and power plant. The promoters are H. T. Julius Fuethman, Henry C. Joehuk and W. H. Thompson.

THE MOLYNEUX ELECTRIC MANUFACTURING COMPANY, Buffalo, N. Y, capital stock $30,000, has been incorporated to make and sell articles covered by the Barton S. Molyneux patents. The promoters are H. Walter Webb, Edgar Van Etten and A. C. Leonard, New York.

THE BOYNTON MULTIVOLT BATTERY COMPANY, Brooklyn, N. Y., capital stock $10,000, has been incorporated to make and sell electric apparatus, batteries, etc., etc. E. S. Boynton; Brooklyn, Abraham Strauss and Peter Kemble, New York, N. Y., are the promoters.

THE CLINTONVILLE ELECTRIC LIGHT AND POWER COMPANY, Clintonville, Wis., capital stock $8,000, has been formed to operate an electric light and power plant at Clintonville. D. S. Stewart, L. M. Stewart, Clintonville, and P. A. Stewart, Morris, Wis., are interested.

THE BALLSTON ELECTRIC RAILROAD COMPANY, Ballston Spa, N. Y., capital stock $200,000, has been formed to build and operate a street surface road 10 miles long. Thos. Craig, Trenton, N. J. E. W. Smith, New York and F. R. Barnes, Ballston Spa, N. Y., are interested.

THE CENTRAL WISCONSIN ELECTRIC RAILWAY COMPANY, Oshkosh, Wis., capital stock $1,000,000, has been incorporated to build an electric road from Oshkosh to Kaukauna. W. F. Gruenewald, Oshkosh; M. L. Campbell, Neenah; T. E. Ryan, Waukesha, Wis., are interested.

THE JACKSON, WELLSTON AND McARTHUR RAILWAY COMPANY, Wellston, O., capital stock $10,000, has been incorporated by Isaac E. Adams, Daniel J. Ryan, Edwin R. Sharp and others for the purpose of building and operating an electric railroad through Wellston to McArthur.

THE KING SOLOMON MINING AND POWER COMPANY, Chicago, Ill., capital stock $1,000,000, has been formed to develop and locate mining property, and to furnish light, heat and power, electric or otherwise; also to construct railways, etc. The promoters are John Casselman, Arthur B. Lewis and Harry C. Igel.

THE COMPTON ELECTRIC SERVICE COMPANY, New York, maximum capital stock $300,000, has been formed to manufacture and sell electrical and mechanical devices, appliances, apparatus, etc. Geo. L. Thomas, Baltimore, Md., Melvin Compton, Newark, N. J., and J. Fred Clasby, Elizabeth, N. J., are interested parties.

THE ELECTRIC PURIFIER COMPANY, Chicago, Ill., capital stock $300,000, has been formed to manufacture and sell electric and other purifiers and also to buy and operate patents for the above purposes. Geo. H. Reynolds, A. B. Jenkins, Julius Kessler, Wm. T. Rankin, Wm. M. Cully, and Henry L. Williams, are the promoters.

THE JACKSON, WELLSTON AND McARTHUR RAILWAY COMPANY, Wellston, O., capital stock $10,000, has been formed to build, acquire, or operate a railroad to be operated by steam, electric, horse, or other motive power. Isaac E. Adams, Dan. J. Ryan, Edwin R. Sharpe, Chas. Kinney and Edw. B. McCarter are interested.

THE FORT MADISON WATER COMPANY, Jersey City, N. J, capital stock $275,000, has been formed to construct, maintain and operate water works, gas works, and electric light works. Alfred S. Brown, Louis Hallock, Jr., Robt. H. Dillingham, Herbert F. Hatch, East Orange, and Chas. B. Brown, Jersey City N. J., are the promoters.

THE UNIVERSAL ENGINEERING COMPANY, Baltimore, Md., capital stock $10,000, has been incorporated by Geo. W. F. Vernon, Theodore F. Wilcox, Wm. J. King, Julius Stern and Leopold Stern, to carry on a mechanical manufacturing and industrial business for the sale and manufacture of electrical instruments, machinery and supplies.

THE LORAIN AND WELLINGTON RAILWAY COMPANY, Lorain, O., capital stock $100,000, has been formed to construct and operate a street railroad to be operated by electricity or other motive power; also to furnish electric light and power. H. C. Reddington, E. H. Pierce, John Stang, Q. Gillmore, J. W. Steele, O. F. Carter and Jas. Nicholl, Jr., are the promoters.

THE FREDERICK-McCABE CONSTRUCTION COMPANY, Baltimore, Md., capital stock $50,000, has been incorporated by James F. McCabe, Lawrence N. Frederick, Frank H. Sloan, Lawrence P. McCabe, Francis E. Yewell, Wm. G. Stocksdale and Frank Slingluff to carry on a general constructing and electrical engineering business, make and sell dynamos, accumulators, etc.

THE GUEST-BATES MARINE LIFE-SAVING APPLIANCE COMPANY, Hoboken, N. J., capital stock $100,000, has been formed to manufacture and sell all kinds of marine life-saving apparatus and especially the electric lighting thereof, etc. The promotors are James A. Guest, 1,620 Nineteenth street, N. W., Washington, D. C.; Jas. H. Bates, 321 Hudson street, Hoboken, N. J.; Chas. J. Bates, Englewood, N. J., and Edw. C. Chew, 2,033 P Street, N. W., Washington, D. C.

TELEGRAPH AND TELEPHONE.

MARSEILLES, ILL.—A telephone franchise has been granted to a home company.

BOULDER, COL.—A new telephone line to connect Boulder with the mountain camps is to be built.

DUBUQUE, IA.—C. M. Palmer, representing the National Telephone Company, is seeking to organize a new telephone company.

HENDERSON, N. C.—Steps are being taken to secure a telephone exchange.

MORRISTOWN, TENN.—J. B. Cox, of Knoxville, will establish a telephone exchange.

COLCHESTER, ILL.—John E. Hall has been granted a franchise to put in a telephone system at this place and is in the market for telephones and supplies.

NORTHPORT, L. I.—A scheme is being agitated by Justice Wm. A. Strawson to construct a telephone line connecting all the nearby villages with Huntington.

UNION, S. C.—A telephone line and exchange is to be established by W. D. Arthur, who desires prices on a complete telephone equipment for 50 to 100 subscribers.

NEWARK, O.—The Western Telephone Company, of Chicago, has accepted a contract to build a new telephone exchange, which already has over 200 subscribers.

SPRINGFIELD, MO.—A telephone line will probably be established to connect Springfield, Bolivar, Fair Play, Humansville, Hermitage, Pittsburgh, Urbana, Buffalo and Conway.

SANDUSKY, O.—Upper Sandusky is to have an independent telephone exchange. It will be constructed at once by Geo. W. Hale & Co., who represent the Phoenix Telephone Company, of Indianapolis.

MARSHFIELD, WIS.—A communication from the business men of Grand Rapids has been received by Mayor Eicho, asking for co-operation in the establishment of a telephone line between the two cities.

RICHMOND, IND.—At the regular meeting of the city Council, the Harrison Telephone Company will ask for a franchise, and it is thought the same will be granted. The intention of the company is to put in a $40,000 plant.

ELIZABETH, N. J.—The City Council of Elizabeth granted a franchise to the Elizabeth Mutual Telephone Company to erect poles, establish an exchange, etc., in the city. The company will furnish the city with police call boxes.

CHICAGO, ILL.—The present telephone system in the stockyards which is run in connection with the Stock Yards patrol, is likely to give way to a new telephone system. It is reported that packers are arranging to put in a new system.

UPPER SANDUSKY, O.—The Phœnix Telephone Company has been granted a franchise to erect and operate a telephone system. The rates are to be $2 for business places and $1 per month for residences. The rate now paid by the town is $3 per month. It is expected that the new system will be in operation in six months.

HAMILTON, O.—The franchise recently granted to a corporation giving it the privilege to string wires erect poles for telephones and telegraph purposes through the city, has been sold to another company. The new company was organized by the election of Jos. B. Hughes, president; F. W. Witaker, vice-president, and Thos. M. Boyd, treasurer.

ELECTRIC LIGHT AND POWER.

PHENIXVILLE, PA.—Phenixville streets are to be lighted by electricity.

STRATFORD, CONN.—The town of Stratford is to have street electric lights.

WAKEFIELD, NEB.—Wakefield is talking of putting in an electric light plant.

FLORENCE, ALA.—The Cypress Creek water power is to operate a large electric plant. Address Mayor G. W. Swartz.

PORT ARTHUR, ONT.—W. P. Cooke will put in a 750-light incandescent plant in connection with the present railway plant.

CLINTON, N. J.—Robert Thirkell has purchased the Clinton electric light plant and will make a number of improvements.

FRENCHTOWN, N. J.—It is rumored that an electric light plant will be one of Frenchtown's improvements in the near future.

JANESVILLE, WIS.—The H. A. Doty Light and Power Company has been succeeded by the Bower City Light and Power Company.

CLINTON, N. J.—R. Thirkell has purchased the Clinton electric light plant for $3,640 50, and a number of improvements will be made.

UTICA, N. Y.—Wm. S. Doolittle, Chas. I. Williams and Thos. N. Mooney will organize a company to furnish light and power to the city of Utica.

BROCKTON, MASS.—There is a big scheme afoot in Brockton for the organization of a new electric light company on the co-operative principle.

CHESTER, PA.—The stockholders of the Chester Electric Light and Power Company contemplate some extensive improvements it is understood.

BALTIMORE, MD.—The Mt. Washington Electric Light and Power Company has purchased a site at Mt. Washington upon which they will erect a power house.

ERIE, PA.—The city has awarded the street lighting contract to the Edison Electric Light and Power Company. The price is 17 cents per 2,000-cp lamp per night.

FOX LAKE, WIS.—Fox Lake is commencing to agitate the question of electric lights. The village has exceptionally favorable conditions for the location of a plant.

JACKSON, TENN.—The Electric Car Company has been granted permission to construct an electric plant for lighting the city with both arc and incandescent lights.

CHELSEA, MICH.—Address the Mayor concerning the establishment of 20 arc lights at $1,680 per year, the lights to be 2,000 cp, and the contractors to furnish all the accessories.

NORRISTOWN, PA.—A bill was introduced by Hon. B Witman Dambly asking an appropriation for the Norristown Hospital for the Insane of $12,000 for an electric plant.

MENDON, MICH.—W. P. Custard, Alex. Custard, M. Flewelin, H. C. Clapp and Geo. Avis have organized a stock company with a capital of $12,000 to put in an electric light plant.

NORMAL, ILL.—It is contemplated by the management of the Normal electric light plant to remodel the entire plant next summer and put in a new dynamo, engine and boiler.

HARTFORD, CONN.—Both Boards of the Common Council have voted for action that will result in placing under ground all electric wires in the centre of this city except the trolley wires.

DENVER, COL.—The Gilman electric plant has been purchased by the Tip Top Mining Company for $20,000. It is operated by water power, and is equipped so as to supply both light and power.

BALLSTON, SPA, N Y.—The Ballston Spa Electric Light and Power Company has added a new 125-hp engine and a new dynamo. This gives 225 hp and a capacity of 3,000 incandescent lights.

NEW CASTLE, PA.—The New Castle and Tin Plate Company has awarded a contract to the Morgan Engineering Company, of Alliance, O., for a large electrical plant, comprising electric cranes, etc.

NEVADA, MO.—The associated water, gas and electric light companies have effected an organization. F. J. Tygard, of Butler, is president, and C. F. Strohm, of Nevada, secretary and treasurer.

DALLAS, TEX.—C. L. Wakefield and his associates are seeking a franchise to put in a modern plant to cost $40,000, the object being to furnish light and power in competition with the present company.

LAMPASAS, TEX.—The Lampasas Electric Light, Water and Power Company is in the market for electric light machinery, including lamps, storage battery, Nos. 8 and 11 wire, insulator, switches, etc., etc.

SANDY HILL, N. Y.—W. B. Baldwin has disposed of his interest in the Electric Light and Power Company, the Power Company, and the Spring Brook Water Company to G. F. Underwood, of Fort Edward.

IOWA FALLS, IA.—The company to which has been given the franchise to construct and operate an electric plant in Iowa Falls has notified the city officials that it will not be able to carry out the contract.

HILLSBOROUGH BRIDGE, N. H.—A syndicate of gentlemen have purchased land and water power on the Contocook River, about two miles below this village, on the Henniker road, where an electric plant will be erected.

CANANDAIGUA, N. Y.—The Board of Water Commissioners has decided to erect a power house somewhere near the lake and to transmit the power from there to the pump house on Sutherland's Point by electricity. Bids to be called shortly.

READSBORO, VT.—Mr. W. S. Kelley, of Boston, formerly a Lowell resident, has purchased Howe's Pond in Readsboro, Vt., and proposes to put in a plant for the generation of electrical power to be transmitted to North Adams which is nearby.

CARROLLTON, ILL.—Conrad R. Hensen, of Virden, has submitted to the Carrollton City Council a proposition to establish and operate an electric light plant. The matter was referred to a special committee to investigate and report at next meeting.

MARSEILLES, ILL.—At the meeting of the Council, the electric light question was informally discussed and the committee instructed to get figures from the Water Power Company on the same number and location of arc lights as were formerly furnished.

NORTH ADAMS, MASS.—P. G. Carpenter, of this town, has sold to W. S. Kelley, of the Boston General Electric Company, Howes Pond and over 500 acres of land in Readsboro, Vt. It is believed that the electric company will build a large electric plant there.

LE ROY, N. Y.—The Le Roy Hydraulic Electric Company is circulating a petition to the village board of trustees asking permission to erect poles on the streets in order to furnish light, fuel and power to those wishing same. The petition is being well signed.

REDLANDS, COL.—At the annual meeting of the Electric Light and Power Company, it was voted to issue bonds in the sum of $100,000. The old issue of bonds will be taken up with one-half of this amount, the balance being used to improve and make additions to the plant.

MT. STERLING, KY.—Address the Mayor regarding an electric light plant to be established. A trolley system is also contemplated the power for which is to be generated by means of water works eight months of the year, and by steam the remaining four. Machinery is wanted.

SAGINAW, MICH.—A plan is under consideration by the members of the Council to establish an electric light plant at the east side water works, and light the streets, city hall, police station, parks and other city property, thus saving the taxpayers the profits which the other electric light companies made of city contracts.

MARBLEHEAD, MASS.—The new municipal plant was started up Jan. 22. The plant has a capacity of 200 arc lights and 1,000 incandescents. There are two boilers of 250 hp each, and two cross-compound condensing Corliss engines of 200 hp each, with all the necessary appurtenances. The appropriation for the plant was $60,000.

MILWAUKEE, WIS.—At the meeting of the Council the following resolution was adopted: That the engineer be, and the same is hereby requested, to prepare plans and specifications for the construction and erection of a municipal lighting plant or plants, suitable for lighting the streets of Milwaukee by electricity, and to submit the same, with an estimate of cost, to the Common Council.

BLACKSTONE, MASS.—As a result of the recent agitation in this town and Woodsocket, the Selectmen of Blackstone have received an offer from R. Schefbaner, of Paterson, N. J., to put in a plant in this place. He offers to put in a plant and furnish 29 lights per night, all night, and every night at 40 cents per night on a contract for five years, the town to have an option of buying the plant at any time after one year to ten years.

BUFFALO, N. Y.—A 10-story office building will be erected on Ellicott square bounded by Main, Swan, Washington and South Division streets. John N. Scatcherd is president of the Ellicott Square Company. Sixteen quick-running elevators will convey passengers in the building, to be run by electricity, if the transmission of Niagara power is completed by the time the building is finished. The building will have its own electric equipment.

SYCAMORE, ILL.—The Frank C. Patton Mfg. Co. was granted a franchise by the City Council to erect another electric light and power plant in this city. The business of the Sycamore Electric Light Co. has increased so largely that they will erect a new plant and put in larger engines and dynamos on the land recently purchased for that purpose. The old electric power house will be utilized to heat stores by steam conveyed by pipes underground. A stock company is being formed for that purpose.

WEYAUWEGA, WIS.—A special village election will decide whether this village will have electric lights or not. A few weeks ago the Wood & Gumaer Manufacturing Company and the Badger Manufacturing Company, of this place, made an offer to the Village Board, whereby they agree to supply the village with 10 arc lights for $450 per year, with the privilege of 15 lights at the same rate in consideration of a 20-year franchise being granted by the Board. The Village Board decided to submit the question to the people.

THE ELECTRIC RAILWAY.

CORSICANA, TEX.—The city is considering a proposition made through J. A. Townsend to build an electric railway.

OGONTZ, PA.—A new electric power house is to be built to supply the People's Traction Company's trolley extension to Jenkintown.

SIOUX CITY, IA.—The Traction Company has let the contract for a power generator to the Sioux City Electrical Supply Company.

ALBION, N. Y.—The Waterport Electric Light, Power and Railroad Company has adopted the Beecher storage battery railway system.

ANDERSON, IND.—The work of surveying right of way, etc., for Chas. L. Henry's Gas Belt Electric Railway has been commenced.

COLUMBUS, GA.—The Drake & Stratton Company has been granted a charter for the construction of an electric railroad in Phoenix City.

GRAFTON, W. VA.—Baltimore parties, it is reported, are considering a project to build about 50 miles of electric line to connect about 10 towns.

STROUDSBURG, PA.—The Delaware Valley Electric Railway is in the hands of M. F. Coolbaugh and Edward H. Peters, of Bushkill, as receivers.

BALTIMORE, MD.—The City and Suburban Company may build a trolley line along Eager street in Northwest Baltimore. Nelson Perin, president.

CHARLOTTESVILLE, VA.—The Electric Street Railway Company has purchased the only horse car line in the city, and will rebuild it for electric motors.

MEMPHIS, TENN.—The Raleigh Spring Electric Railway Company will extend its electric line to Raleigh Inn. General Manager Jones may be addressed.

LONDON, ONT.—The London and Springbank Electric Railway Company is applying for a charter to construct an electric railway from London west to Springbank.

HAMILTON, ONT.—The Hamilton Iron and Steel Company is applying to the legislature for power to construct an electric tram railway in connection with their works.

MONTICELLO, KY.—Business men are trying to organize an electric railway company to build a trolley line to Burnside, Ky. F. H. Bagby or J. W. Tuttle may be addressed.

ANNISTON, ALA.—It is stated that a company is being organized to build an electric line from Anniston to the St. Clair coal field and the Coosa River. The distance is 20 miles.

HENDERSON, KY.—The Henderson City Council decided not to act on the proposition to erect an electric light plant until a vote of the people could be taken on the question.

MECHANICSBURG, PA.—The Cumberland Valley Traction Company is pushing the construction of its line to Mechanicsburg, and expects to have it completed by Sept. 1, 1895.

BIRMINGHAM, ALA.—C. A. Avery, of the company which has bought the Highland Avenue and Belt steam dummy line, states that eventually it is to be rebuilt for electric traction.

ROME, GA.—Eastern parties have become interested in the City Electric Railway Company and will construct several switches and add two motor cars to its equipment. J. B. Marvin is manager.

WATERLOO, ONT.—The Grand Valley Railway Company is applying for power to construct a steam or electric railway, to run from the town of Berlin to Brantford, Lestowell, Stratford and Elora.

NEW LONDON, CONN.—There does not seem to be much show for the construction of the proposed electric road between this city and Norwich as far as can be learned. The cost of the road would be $350,000.

GETTYSBURG, Pa.—General E. M. Hoffer, of the Gettysburg Electric Railway Company, which was sold to Chicago and Philadelphia parties, has consented to remain this year in the capacity of president of the road.

PORT TAMPA, FLA.—Edward R. Gunby and A. H. Hayden are among the incorporators of the Port Tampa Street Railway Company, which intends building twelve miles of electric line in Tampa and Port Tampa.

SARATOGA, CAL.—A new electric road is to be built to connect Saratoga with San Jose and Santa Clara. Work is to be commenced at once, and it will probably be completed early in July. Its total length will be 12 miles.

EAST WEYMOUTH, MASS.—An enthusiastic meeting was held in G. A. R. Hall, East Weymouth, in the interest of the future extension of the franchise of the Quincy and Boston Street Railway Company. W. C. Earle may be addressed.

NEW BRITAIN, CONN.—John Crilly, of Hartford, purchased 1½ acres of land on North street in this city for, it is thought, a power house for an electric railway company in Hartford which proposes to extend its lines to New Britain.

COXSACKIE, N. Y.—There is much talk in favor of an electric railway to run from Coxsackie to Greenville, a distance of 13 miles. Public meetings have been called and it is believed that sufficient capital will be subscribed to build the road.

PORTLAND, ME.—A petition signed by President William R. Wood, of the Portland Railroad Company, asking for right to equip its lines in the city with electricity was received and a public hearing directed at 2.30 p. m., February 13, on the subject.

WESTCHESTER, PA.—It is proposed to build an electric railway up the Westchester and Wilmington pike. The Wilmington folks are willing to do their share, and they have asked Burgess Way if the people here would come forward to help the matter.

SPRINGFIELD, O.—A 25-year franchise was granted by the County Commissioners to E. S. Corson and others for an electric railway line from Springfield to Clifton. Mr. Corson is backed by Philadelphia capitalists and says the road will be built next spring.

GREENFIELD, MASS.—A syndicate of capitalists in the eastern part of the State, headed by H. T. Prince, of Leominster, proposes building an electric road from Greenfield to Turner's Falls, via Cheapside and Montague City, at an estimated cost of $100,000.

WASHINGTON, D. C.—The Washington and Maryland Railway Company is endeavoring to secure a franchise for a line in the District to connect with a Baltimore road. W. Welsey Schoepf is interested. He is manager of the Eckington and Soldiers' Home line.

LITTLE ROCK, ARK.—It is stated that the General Electric Company of Chicago will endeavor to secure the Capital and City Electric road and spend about $75,000 in improvements and extensions. B. E. Sunny is local representative of the Chicago company.

SOUTH BRAINTREE, MASS.—The Braintree Street Railway Company intends building a new road between Braintree and Randolph, and also making some extensive changes in the line between Quincy and Holbrooke. Chas. J. Beatley, superintendent, may be addressed.

ELLICOTT CITY, MD.—It is stated that arrangements are being made to extend the Edsondson avenue, Cattonsville and Ellicott City line to Ellicott City. The line is contracted for to a point within two miles of Ellicott City. Hon. John Hubner, of Baltimore, is interested.

WASHINGTON, D. C.—The projectors of the East Washington Belt Line Railway Company were given a hearing by the sub-committee of the House District Committee upon the bill authorizing the construction of that road. They promise to have the road running within six months.

DELAVAN, WIS.—Chicago and Minneapolis capitalists are interesting themselves in a scheme for the construction of an electric line from Harvard to Delavan via Walworth, Fountana and Geneva Lake, to connect with the Chicago, Milwaukee and St. Paul Railway at Delavan.

QUEENSTOWN, MD.—It is now proposed to extend the electric railroad projected from Queenstown to Denton and Chestertown across the Eastern Shore of Maryland to Lewes and Rehoboth, Del. Wm. H. Bosley, of Baltimore, and Wilmer Emory, of Centreville, are interested.

SCOTTDALE, PA.—The borough Council of Scottdale has granted the right of way over Broadway, Market, Pittsburgh and Mulberry streets to the Scottdale, Evenson and Bradford Electric Street Railway, and the company proposes to commence the construction of the road at an early date.

VICTORIA, B. C.—The Victoria Electric Railway and Lighting Company contemplates building a water power plant of about 1,000 hp to supplement its present steam plant. It also intends to increase the present electrical equipment in the way of alternators and street railway apparatus.

OSHKOSH, WIS.—The Central Wisconsin Electric Railway Company was formed in this city for the purpose of building an electric street line and intersuburban road between Oshkosh and Kaukauna. G. F. Kedham, G. J. Kobusch and Otto von Schrader are directors. The capital is $1,000,000.

TACOMA, WASH.—The Point Defiance Railway has been sold to S. Z. Mitchell, of Portland, who represents the General Electric Company, and is likely to be connected with the Tacoma Railway and Motor Company's lines, the latter company being controlled by the General Electric Company.

READING, PA.—At a meeting of Council a report was received from the highway committee recommending the passage of the bill to permit the Reading and Southwestern Electric Railway to extend its tracks on Franklin street and elsewhere, providing an edging of granite blocks is placed on both sides of the rails.

OXFORD, PA.—Two capitalists of New York were in Oxford looking after the interests of a proposed electric railway between Oxford and Newark, Del., to be known as the Oxford and Newark Electric Railroad. They were guests of the Oxford Board of Trade. It is thought that the road will be built if the right of way can be secured.

GETTYSBURG, PA.—The Gettysburg Electric Railway has been sold to J. Luttrell Murphy, of Chicago, and Walter B. Kendall and John A. Connelly, of Philadelphia. The purchasers will complete the road to the Maryland line, there to connect with the Maryland system of trolley roads. They are to obtain possession of the franchise March 1.

HACKENSACK, N. J.—At a meeting of the Board of Road Commissioners of the township of Richmond an application was made by the Bergen County Traction Company for a franchise for a trolley road. The road is to run from the Bergen County line to Englewood. Nothing was done by the commissioners on the application and the matter was laid over.

GREENSBURG, PA.—The ordinance passed by the town Council of Jeannette granting the franchise for the right of way through that borough to the Greensburg, Jeannette and Pittsburgh Street Railway has been returned to the Council by Chief Burgess A. J. Case unsigned, with a number of exceptions noted. It is thought the Council will amend the ordinance.

BELLEVILLE, N. J.—A meeting will be held in Passaic Hall at which the Passaic and Newark Electric Railway Company will make public application for a franchise enabling them to operate a double-track overhead trolley line upon Washington avenue from Franklin township line to Jeroleman street. Their application is viewed with favor by the township committee and the citizens at large.

HARRISBURG, PA.—General Manager Lincoln Nissley, of the Citizens' Passenger Railway Company, of Harrisburg, has resigned. In the recent election for president of the East Harrisburg Passenger Railway Company, John Q. Denny, the present incumbent, was declared re-elected. His opponent, Mr. T. D. Greenawalt, has contested the election, and the matter will be settled in the Dauphin county courts.

KENNEBUNKPORT, ME.—Among the bills introduced in the Maine legislature is one to incorporate the York County Electric Railway Company with authority to operate an electric road through Kennebunkport, Lyman, Alfred, Waterboro, Limerick, Parsonfields, Cornish, Limington, Holis, Buxton, Saco and Biddeford. The capital is $1,000,000. W. A. Roberts, Edgar A. Hubbard and others are the incorporators.

NEWBURYPORT, MASS.—A meeting of the incorporators and others interested in the building of the Essex County street railway under the legislative act of 1893 will be held at Ipswich the coming week. The incorporators represent the business interests of Newbury, Rowley and Ipswich, the three towns through which the new road will pass. It is anticipated that work will be commenced early in the spring.

WASHINGTON, D. C.—Representative Childs, of Illinois, introduced in the House a bill to incorporate the National Central Railway Company. It creates Wm. Dollin, J. C. Caldwell and others, of Chicago; John Bell, of BentonHarbor, Mich., and others, a corporation, and authorizes it to construct and maintain a continuous electric railroad from the Hudson River in or near Jersey City, or from some point in New York City to San Francisco.

PRINCETON, N. J.—The managers of the Trenton Passenger Railway Company had a conference with the Princeton borough authorities in regard to right of way through the borough. The company is planning to extend its line both to Princeton and Bordentown at as early a date as possible. John L. Kuser, the secretary and treasurer of the company, stated that nothing definite resulted from the conference, but that they felt sure they would get the franchises desired eventually.

MISCELLANEOUS NOTES.

THE MONTREAL ELECTRIC CLUB, at its recent annual meeting, elected the following officers: W. B. Shaw, president; Mr. Edwards, vice-president; C. Dantor, secretary.

ROBERT LAIDLAW, president of the Laidlaw-Dunn-Gordon Pump Company, of Cincinnati, was elected treasurer of the National Association of Manufacturers, which convened at Cincinnati the third week in January. Mr. Laidlaw was one of the leading spirits in organizing the association, and much of the success of the convention was due to his superior executive skill and untiring energy. The delegation was banqueted at the new plant of the Laidlaw-Dunn-Gordon Pump Company.

LAWYER SIMON STERNE, of New York, has obtained from Judge O'Brien a temporary injunction restraining the Metropolitan Telephone and Telegraph Company from removing, or interfering with his use of the telephone in his office. The Metropolitan Company, Mr. Sterne claims, had notified him of its intention to remove the instrument on Feb. 1, because he declined to submit to what he considered an arbitrary increase in rental. The company claims that the expense of putting its wires underground and the furnishing of a metallic circuit necessitated an increase in rates. Mr. Sterne says the rental, as compared with the rates charged in European cities, are entirely too high and he asks the courts to interfere.

Trade and Industrial Notes.

F. H. ALLING, New Haven, Conn., is meeting with success in introducing in electric plants the Common Sense Oil Filter, formerly manufactured by W. E. Crane, of Hartford.

THE COLBURN ELECTRIC MANUFACTURING COMPANY is building on Winter street, Fitchburg, Mass., a brick machine shop 155x43 feet and two stories high, with boiler and engine house 42x40 feet.

THE CENTRAL ELECTRIC HEATING COMPANY, Havemeyer Building, New York, is placing on the market an electric glue pot, in which the vessel containing the glue sets in an electrically heated water bath. The advantages claimed are steady temperature and minimum attention.

THE VIADUCT MANUFACTURING COMPANY, Baltimore, reports the list of some of the telephone exchanges which are using its magneto telephone exclusively with great satisfaction: West Winsted, Conn.; Great Barrington, Mass.; Emporium, Pa.; Vineland, N. J.; Liberty, N.Y.; Reidsville, N. C.; Vinton, Tenn.; Suffolk, Va., and Gaffney, S. C.

THE OHIO VALLEY ELECTRICAL ENGINEERING COMPANY, of Cincinnati, O., has been retained by the Kings Powder Company and the Peters Cartridge Company as consulting engineers in charge of the work of installing two 300-kw General Electric generators and is 200-kw Shawhan-Thresher generators, together with a number of motors.

THE ELECTRIC APPLIANCE COMPANY, Chicago, is making a specialty of theatrical electrical devices and has secured control of a number of lighting specialties particularly adpated for theatre work. In fact, this has become so important a department of its business that it is found necessary to issue a special catalogue of this material under the name of "Catalogue of Theatrical Lighting Devices," which is now being extensively distributed.

H. E. COLLINS & COMPANY, sole agents for the Cahall vertical water tube boiler, manufactured by the Aultman & Taylor Machinery Company, of Mansfield, O., have contracted for a 250-hp boiler, using blast furnace gas as fuel, for the Seneca furnace, and for a 500-hp for the Philadelphia Gas Company, at Kelly Station, Pa., and for two boilers for the Solvay Process Company, at Syracuse, N. Y. They are also building the boilers for the new sugar refinery at Havana, Cuba.

THE BERLIN IRON BRIDGE COMPANY, East Berlin, Conn., held its annual stockholders' meeting on Jan. 29. The following Board of Directors was elected: Chas. M. Jarvis, Geo. H. Sage, F. L. Wilcox and Burr K. Field, of Berlin, Conn.; S. Howard Wilcox, of Brooklyn, N. Y.; Julius Burr, of East Berlin, Conn., and H. Peck, of Waterbury, Conn. By vote of the stockholders the capital stock of the company was increased from $300,000 to $500,000. The new issue of stock has all been taken by the old stockholders.

THE BALL ENGINE COMPANY, Erie, Pa., continues to keep its shops well filled with work and has recently taken some good-sized orders. Among recent shipments of electric light engines are the following: Oskaloosa Edison Light Company, Oskaloosa, Ia., two 175-hp direct-connected engines; Chesapeake Light and Power Company, Hampton, Va., one 300-hp cross compound engine; Peninsular Electric Light Company, Detroit, Mich., one 150-hp cross compound engine; Dunkirk, Ind., Electric Light Company, one 100-hp tandem compound engine; Barnesville, O., Gas and Electric Light Company, one 80-hp single cylinder engine; Washington, Mo., Electric Light Company, one 50-hp single cylinder engine; Norfolk Navy Yard, one 80-hp single cylinder engine; Ynga Soledad Plantation, Guantanamo, Cuba, one 35-hp single cylinder engine; Canon City, Col., Electric Light and Power Company, one 100-hp single cylinder engine; Sweetwater, Tenn., Mill Company, one 25-hp single cylinder engine; Crook, Horner & Company, Baltimore, Md., one 125-hp single cylinder engine; L. M. Rumsey Manufacturing Company, St. Louis, Mo., one 60-hp single cylinder engine.

THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, on account of conflicting dates with the convention of the National Electric Light Association, at Cleveland, Feb. 19, 20 and 21, will postpone its regular monthly meeting at New York and Chicago from Feb. 20 to Wednesday, Feb. 27, 1895. The paper to be presented on the latter date is by Mr. H. Ward Leonard, entitled "Notes on Recent Electrical Engineering Developments in France and England," being the results of the author's recent personal observation in electric light, railway, central station and underground practice.

Business Notices.

WOVEN WIRE BRUSHES.—The Belknap Motor Company, of Portland, Me. are the patentees and manufacturers of the best woven wire commutator brush on the market.

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

Illustrated Record of Electrical Patents.

UNITED STATES PATENTS ISSUED JANUARY 22, 1895.

[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

533,078. PRIMARY BATTERY; R. O'Toole, Mechanicstown, Md. App. filed April 3, 1893. In a battery containing oxide of copper as depolarizing material caustic soda solution and zinc, the combination of a perforated jar containing the depolarizing material, covered at top and bottom, and a suspensory rod passing through the top and bottom and secured to a cover or bridge across the jar.

533,083. SYSTEM OF AND APPARATUS FOR CONTROLLING ELECTRIC CURRENTS; W. B. Potter, Lynn, Mass. App. filed Jan. 24, 1893. A plurality of dynamo electric machines each provided with a circuit controller and a series of electromagnetic resetting devices for such circuit controllers actuated by a common circuit.

533,084. RECTIFYING COMMUTATOR AND METHOD OF MAKING SAME; H. G. Reist, Schenectady, N. Y. App. filed Oct. 19, 1894. A commutator composed of registering portions cut from a flanged ring having an internal groove and having suitable insulation between the registering portions.

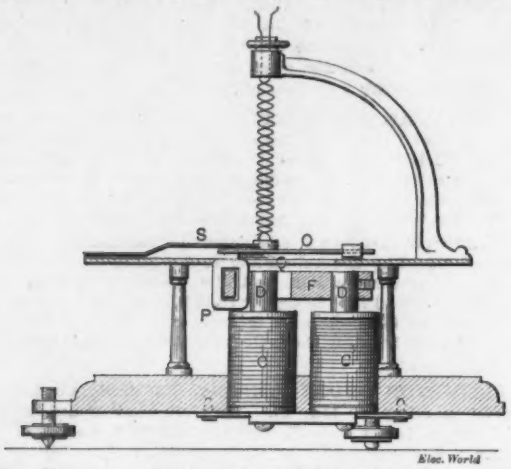
533,100. ELECTRIC ARC LAMP; H. O. Swoboda, New York, N. Y. App. filed March 2, 1894. This comprises a movable carbon support, device for controlling the movement of the same, a tilting frame, a solenoid core controlling the movement of the frame, the solenoid including a spool having a body portion and removable end flanges, the body portion being so formed as to permit notched flanges to be slipped on and locked on a partial rotation of the same.

533,107. ELECTRICAL MEASURING INSTRUMENT; E. Weston, Newark, N. J. App. filed March 11, 1891. This comprises electromagnets, a ring pole piece formed on one of the cores of the magnet and surrounding the other core, a coil surrounding the ring pole, a bar supporting the coil and a suspension device carrying the bar, and an index needle with means for passing a current through the coil and returning the latter to starting point after a deflective impulse has ceased. (See illustration.)

533,108. ELECTRIC MOTOR; C. Wirt, Chicago, Ill. App. filed April 23, 1894. A chrono-electric motor having a pendulum, a contact moved thereby, an electric actuating device, and a contact having a retarded movement toward the pendulum contact, and a free movement in the opposite direction. (See illustration.)

533,130. COMBINED CURB, GUTTER AND CONDUIT FOR ELECTRICAL CONDUCTORS; W. Kingsley, St. Paul, Minn. App. filed Feb. 1, 1893. A combined hollow curb and gutter having its front wall flush with the surface of the paving, and with its rear wall flush with the sidewalk, and a curved removable cover forming the top and also the face or gutter surface of the hollow curb.

533,142. TELEPHONE SYSTEM: J. I. Sabin and W. Hampton, San Francisco, Cal. App. filed April 14, 1894. This comprises a double strand cord



No. 533,107.—Electrical Measuring Machine.

connector, a calling generator, a key adapted when depressed to bridge the generator between the strands, and a second key adapted when depressed to connect the generator between one of the strands and ground.

533,146. APPARATUS FOR SMOOTHING CURRENTS OF DYNAMO ELECTRIC MACHINES; C. E. Scribner, Chicago, Ill. App. filed Jan. 16, 1892. This comprises a source of electricity, several parallel branches between the poles of the source, a telephone transmitter and the primary helix of an induction coil in each branch, and a source of counter electromotive force connected in shunt with the working circuit.

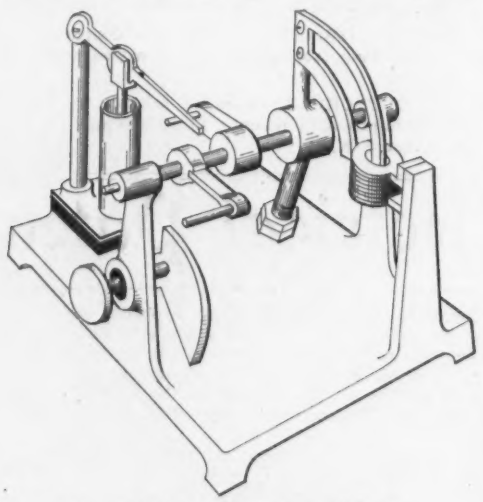
533,147. TELEPHONE SWITCHBOARD APPARATUS; C. E. Scribner, Chicago, Ill. App. filed May 13, 1892. The combination with the connecting plug of a tip and a shank electrically connected together and a sleeve or contact piece insulated from the shank or tip.

533,148. SPRING JACK FOR TELEPHONE SWITCHBOARDS; C. E. Scribner, Chicago, Ill. App. filed May 23, 1892. The combination with a tube or thimble of a narrow test ring in front of the thimble and insulated therefrom, the opening of the test ring being larger than the opening in the tube.

533,154. CIRCUIT CLOSER FOR RAILWAY RAILS; E. C. Wiley, Bristol, Tenn. App. filed May 29, 1894. This comprises the main rail and circuit breaking devices; a rigid supplemental rail anchored to the main rail at its ends, and having about its middle a downwardly projecting arm extending under the main rail, and supporting a portion of the circuit closing devices.

533,183. AUTOMATIC ELECTRIC SIGNAL: H. C. Storrs, Hartford, Conn. App. filed April 20, 1894. This consists of two metallic holding and heat conveying members having spirally formed adjacent ends embedded in a mass of non-metallic sealing material of a fusible or soluble nature.

533,196. COMBINED PORTABLE STAND AND WALL BRACKET FOR INCANDESCENT ELECTRIC LAMPS; H. Horn, Philadelphia, Pa. App. filed Feb. 15, 1892. The combination of a swinging lamp, a shell having



No. 533,108.—Electric Motor.

its tube screwed into a portion of the lamp socket, a cap between the shell and socket, and a weight in the shell.

533,211. ELECTIC ARC LAMP; E. Conrady, Keighley, England. App. filed Dec. 16, 1893. A feed mechanism comprising a resilient strip, elastic connection between the same and the movable carbon, compound gripping levers to act on the strip, and means for controlling the levers.

533,221. BONDING COLLAR; M. M. Jacobs, New York, N. Y. App. filed Sept. 12, 1894. A bonding collar provided with a coating of tin or similar substance, grooved or slotted longitudinally and threaded or roughened interiorly.

553,223. INCANDESCENT ELECTRIC LAMP; G. R. Lean, Cleveland, O. App. filed Nov. 29, 1893. This comprises the bulb, tubular metallic guides sealed therein, leading in wires extending through the guides, and insulating material interposed between the wires and guides.

533,241. GAGE ALARM; W. A. Stafford, Meadville, Pa. App. filed April 17, 1894. A gage having a dial face with a curved slot therein, a segment having a stud and screw working in the slot, a pointer and electric connections for the segment and pointer.

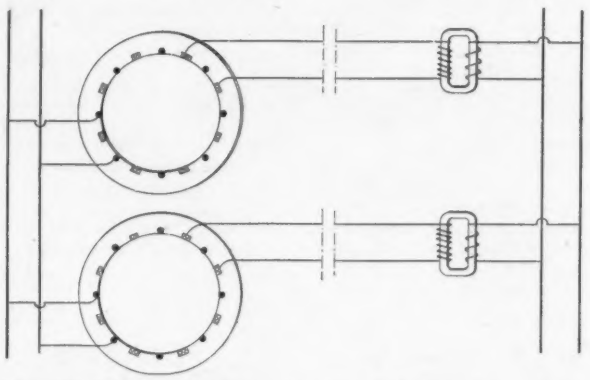
533,244, 533,245, 533,247, 533,248, 533,249, 533,250, 533,378 and 533,379 are patents by Mr. Charles P. Steinmetz on the monocyclic alternating system, and are digested on pages 182–185.

533,254. SIGNALLING TELEGRAPH; F. A. Turner, Chelsea, Mass. App. filed July 27, 1893. This consists of a strip, a punch adapted to act continuously during a break in the main line and a drop adapted to enter the perforation in the strip caused by continuous punching, and a stop for the punching controlled by the falling of the drop to interrupt the operation of the punch.

533,246. WINDING FOR DYNAMO ELECTRIC MACHINES; Charles P. Steinmetz, Schenectady, N. Y. A method of winding dynamo armatures, and more particularly those of machines in which the cross or end connections overlap at the end of the armature or, fields. Such overlappings exist in direct current, alternating and polyphased machines in which there is more than one tooth per pair of poles. The invention consists in arranging the coils in separate sets or sections, whose combined effect is the same as that of the continuously overlapping coils now used, but whose end-bars or cross-sections, while overlapping in each set, do not overlap those of other sets. This enables each set to be removed independent of and without disturbing the others, and also enables the magnetic structure to be divided into two or more separate parts.

533,259. ELECTRIC LOCOMOTIVE; S. L. Wiegand, Philadelphia, Pa. App. filed Oct. 23, 1890. This comprises a shaft, helical pinions turning therewith and engaging toothed wheels, turning in planes diagonal to the shaft and pinions, combined with and located upon the axles of the car wheels.

533,261. BONDING DEVICE FOR ELECTRIC RAILWAYS; J. J. Zimmlee and A. Bournonville, Philadelphia, Pa. App. filed Nov. 30, 1894. A bond for an electric conductor having limbs on the end thereof, the same being adapted to be tightened in position.



No. 533,323.—System of Electrical Distribution.

533,269. RECORDING AMPERE METER; W. H. Bristol, Hoboken, N. J. App filed July 26, 1894. This comprises a stationary coil, a movable coil, two flexible conducting supports for the coil and connecting with the terminals thereof, a recording arm, a flexible support for same, and a knife-edge connection between the movable coil and the support.

533,270. ELECTRICAL MEASURING INSTRUMENT; W. H. Bristol, Hoboken, N. J. App. filed Sept. 24, 1894. An armature composed of a thin disc of iron and a reinforcing plate of non-magnetic material.

533,309. APPARATUS FOR STOPPING ENGINES; L. C. E. Meyer, Paris, France. App. filed Aug. 22, 1894. This comprises a stop valve, a brake consisting of a flywheel roller path eccentric thereto, and rollers of yielding material actuated by compression in the gradually contracting space between the roller path and the flywheel, and electromagnetic mechanism for closing the stop valve and discharging the roller into the roller path.

533,318. CONTROLLER OR SWITCH FOR ELECTRIC MOTORS; W. J. Pohlman, Woodbrook, Md. App. filed Nov. 17, 1894. This comprises a series of contact arms, a rotatable circuit breaker, escapement mechanism for intermittently rotating the circuit breaker, a dental instrument provided with a rotatable spring-impelled finger piece, a flexible shaft connecting a dental instrument with a motor, and a cord passing through eyes on the flexible shaft and connected at its ends with the escapement mechanism, and a rotatable spring-impelled finger piece or drum.

533,323. SYSTEM FOR AND METHOD OF ELECTRICAL DISTRIBUTION OF ENERGY; W. Stanley, Pittsfield, Mass. App. filed Nov. 3, 1894. This consists in running alternators so as to generate currents of like phase, transforming the separate currents into currents of a different potential, and combining such transformed currents so as to produce in the working circuit a combined current of potential like to that of the transformed currents. (See illustration).

533,398. AUTOMATIC ELECTRIC SAFETY SYSTEM FOR RAILROADS; R. R. Snowden and A. C. Ives, Ocala, Fla. App. filed Jan. 26, 1894. A traveling car carrying a circuit and having short circuit connections, one portion of which is made movable and yielding to the force of the air pressure when the car is in motion to open the shunt.